Vol. XLIX

MAY 9th, 1946

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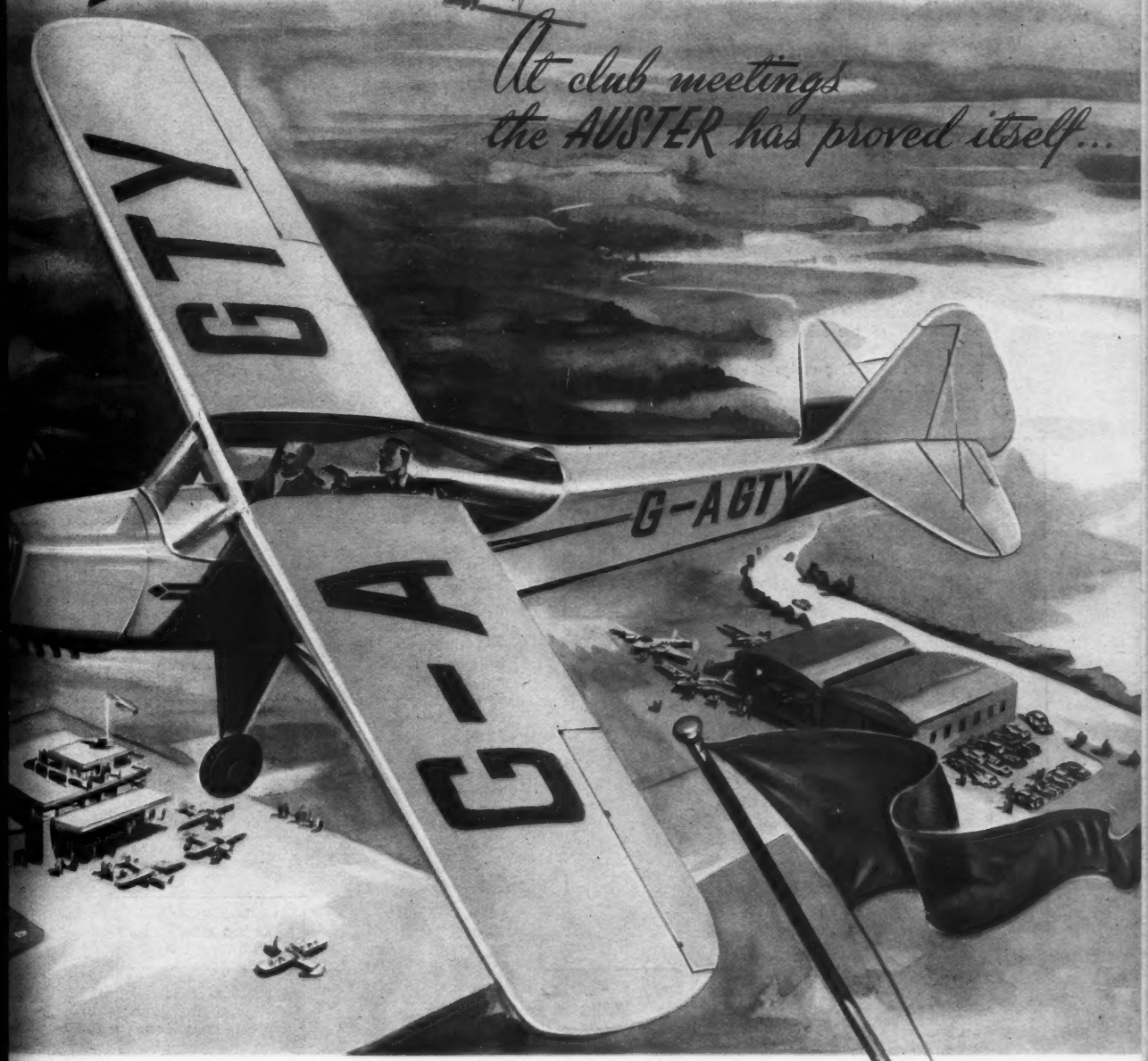

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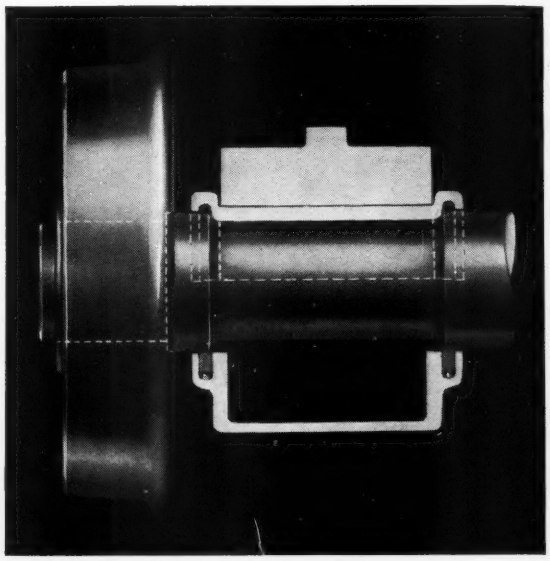

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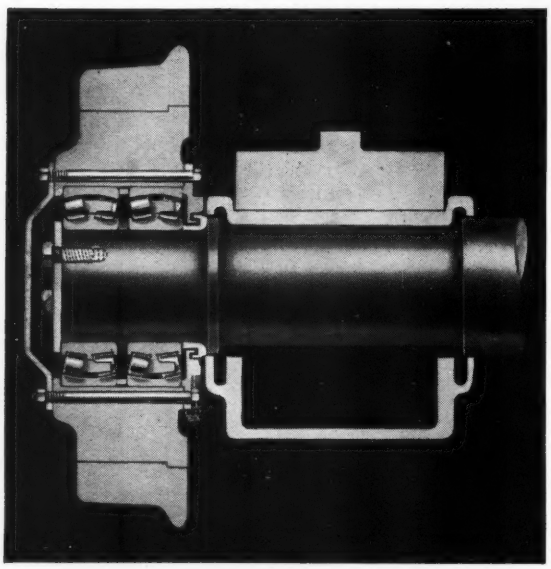

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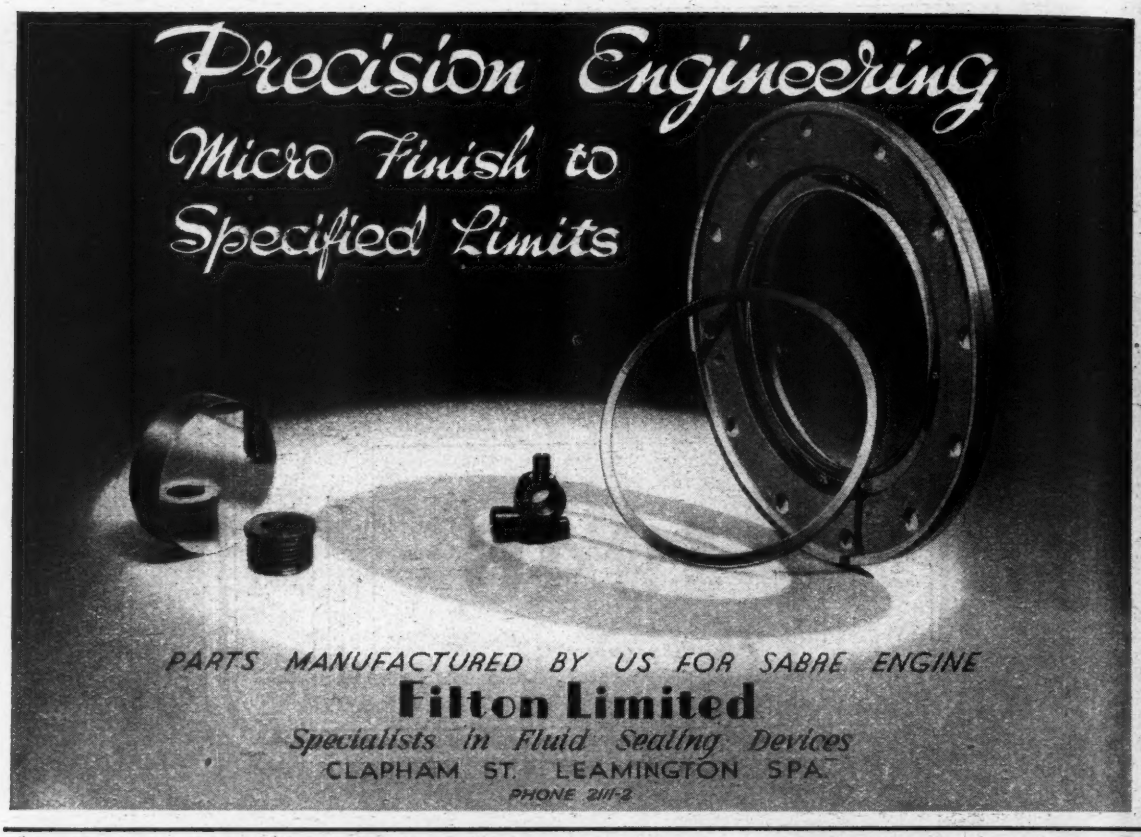

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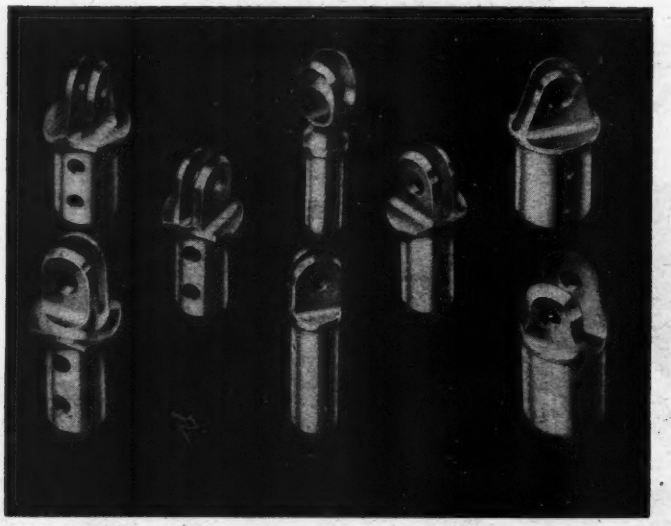

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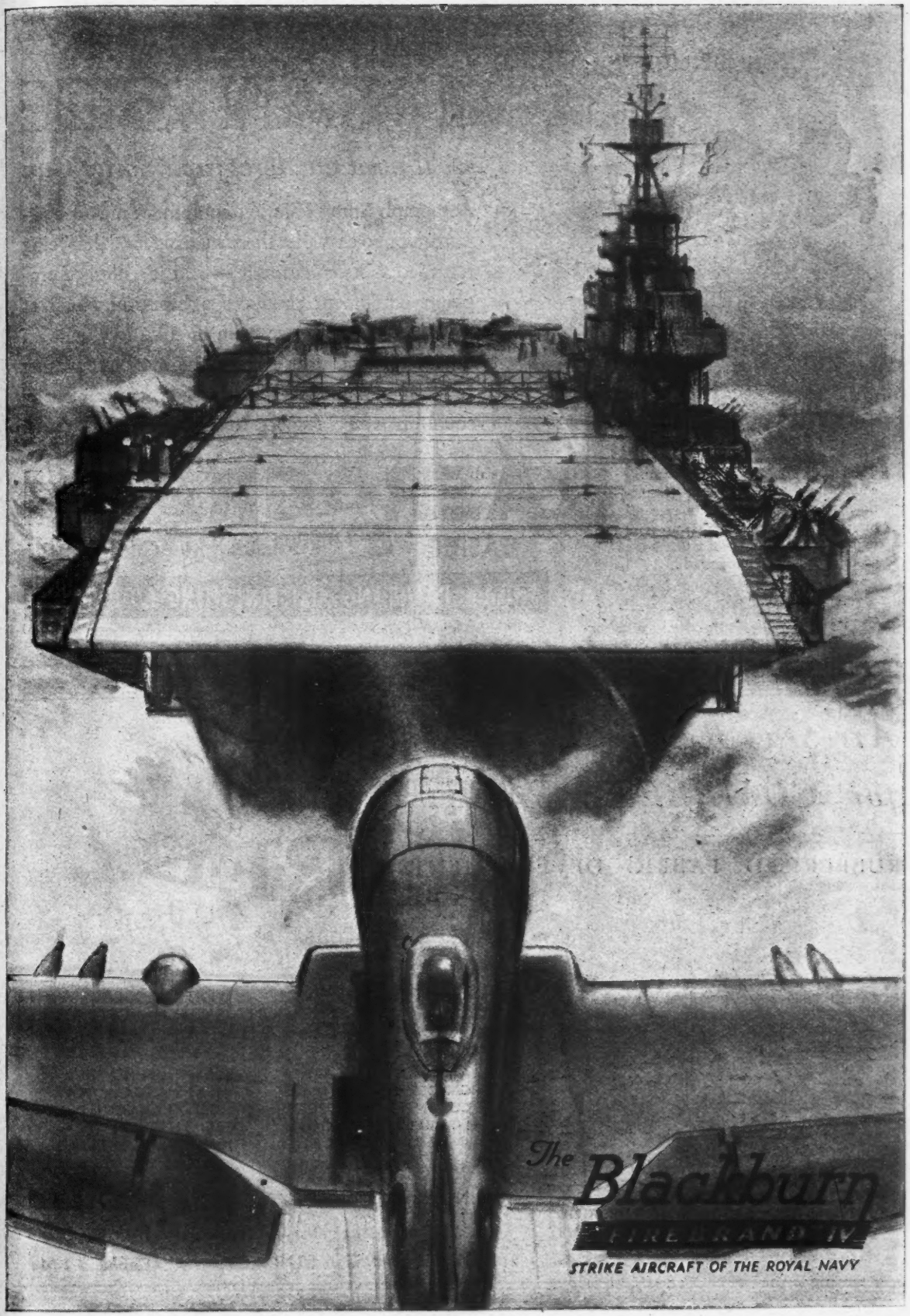
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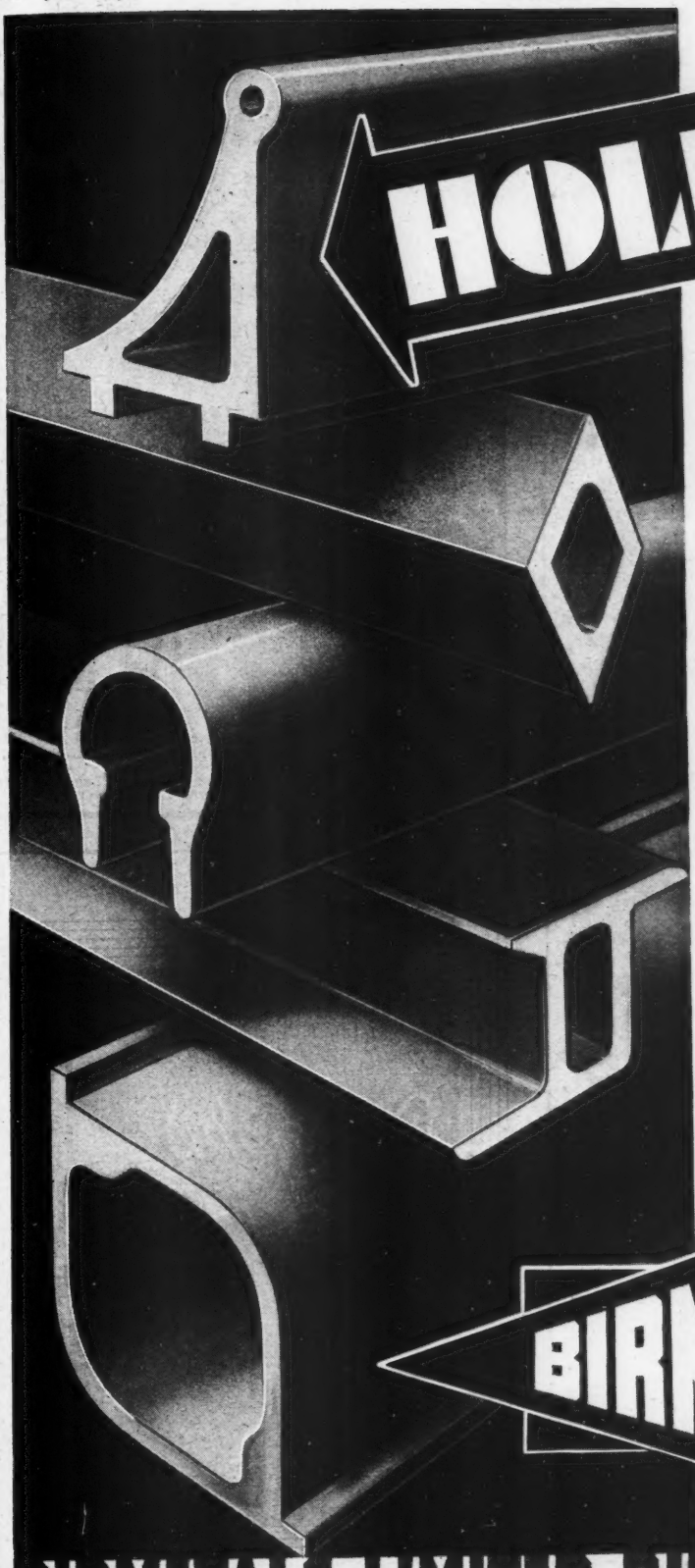

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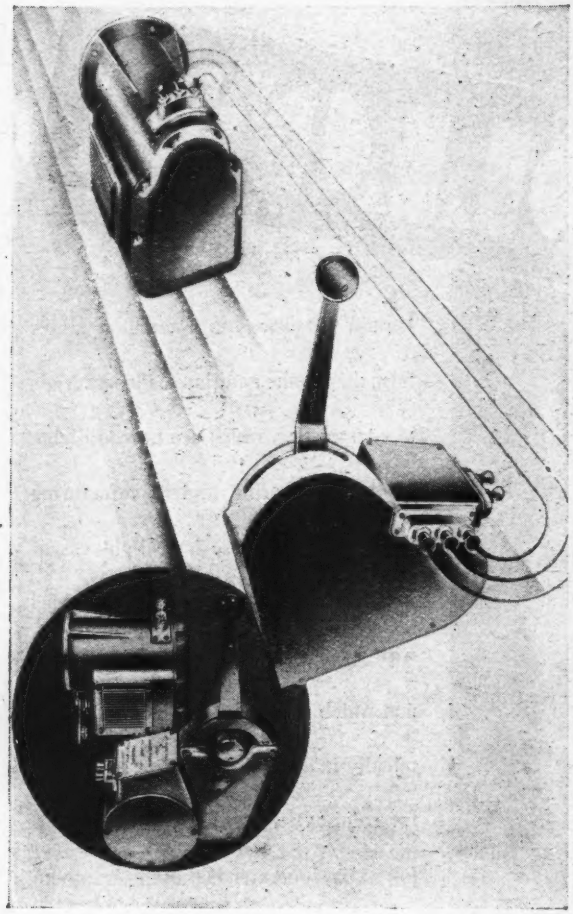

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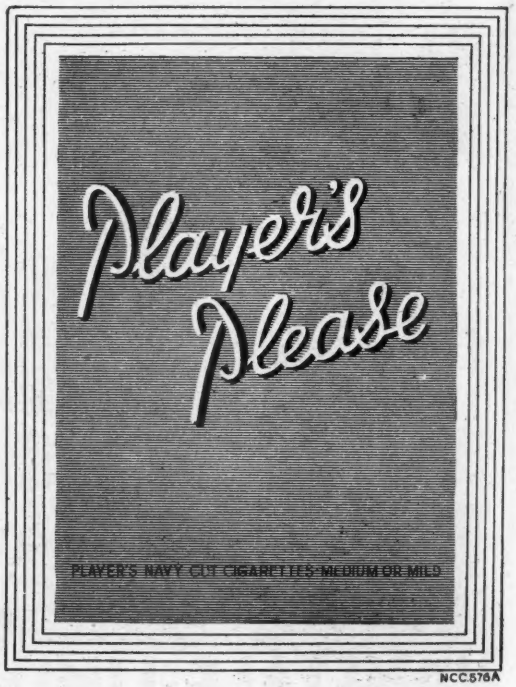

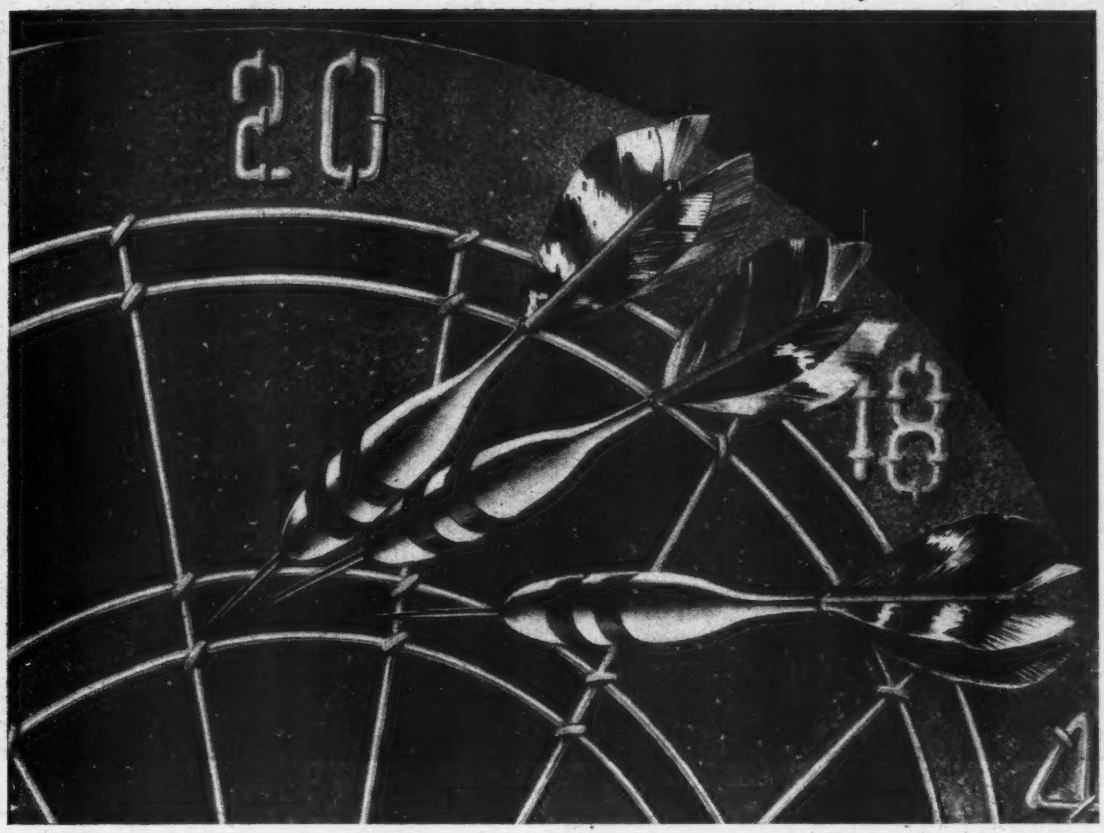

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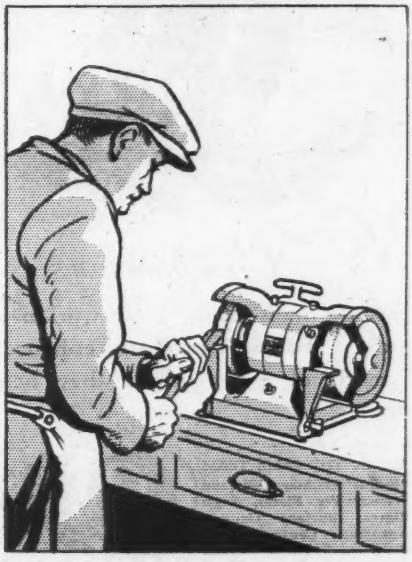

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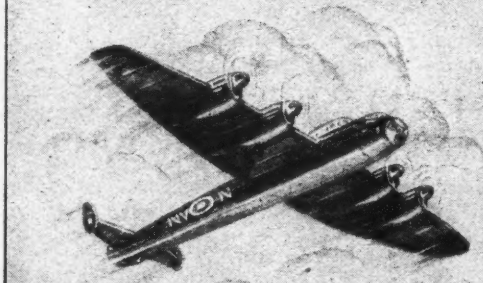

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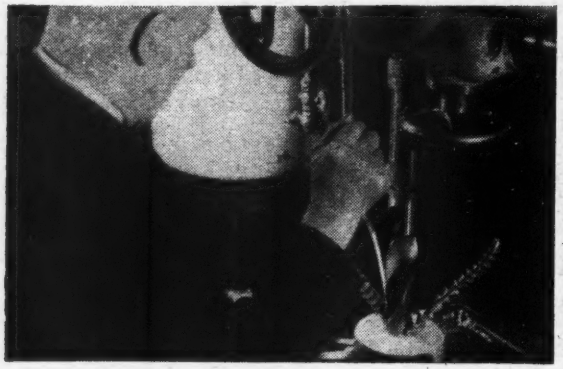

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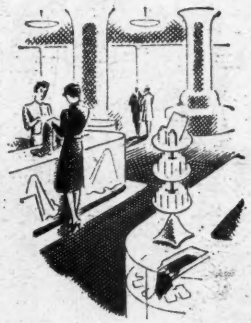

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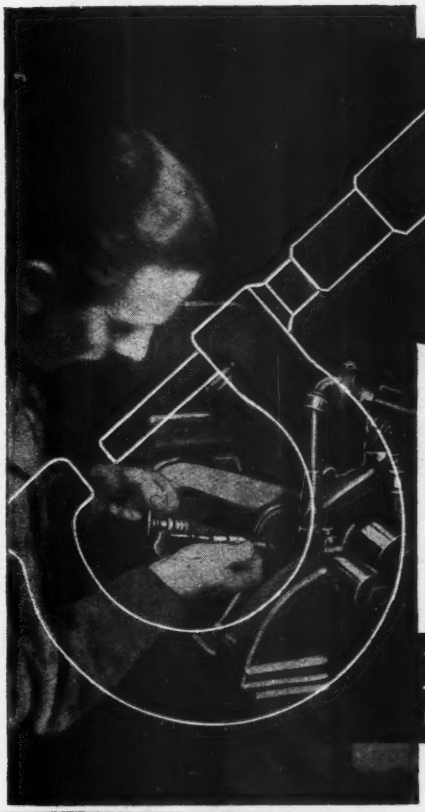

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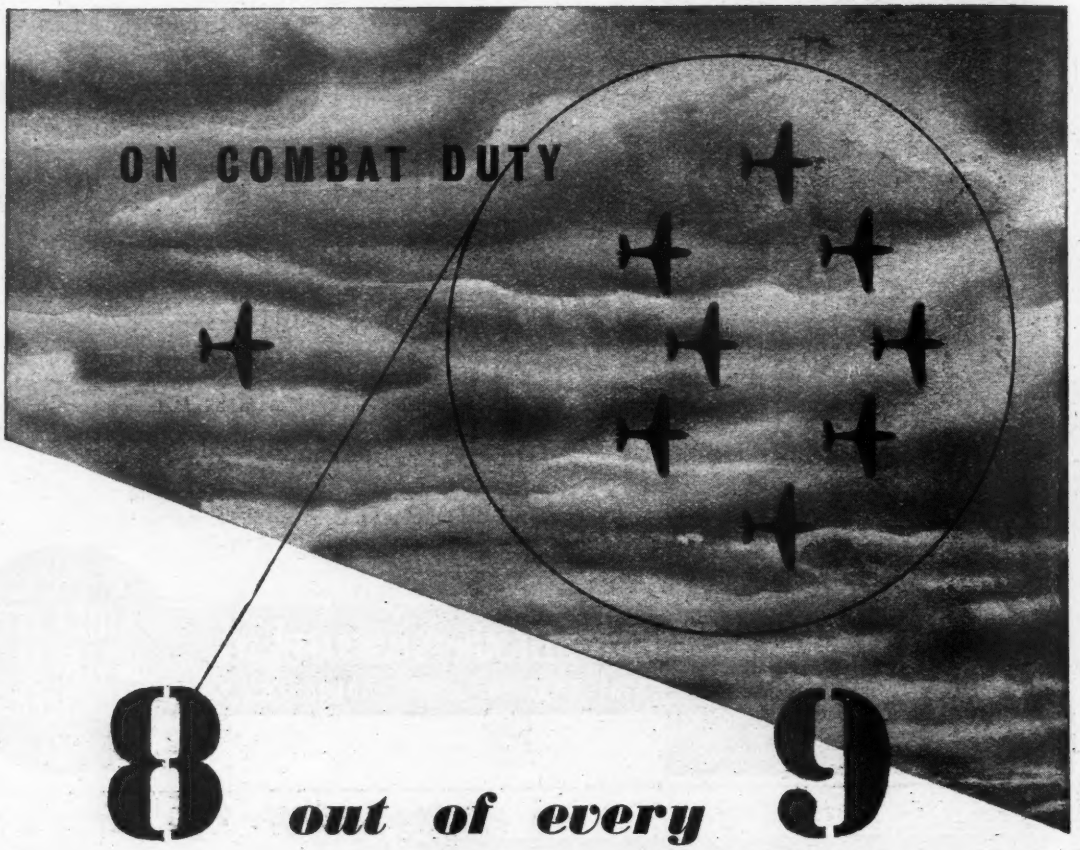

8 out of every 9 British Naval Aircraft were Fairey types

No fewer than eight out of every nine operational aircraft of British manufacture that were delivered to the Royal Navy from all sources in the War were Fairey types.

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FIRST AERONAUTICAL WEEKLY IN THE WORLD : FOUNDED 1909

Editorial, Advertising and Publishing Offices: DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1
Telegrams: Flightpres, Sedist, London. Telephone: Waterloo 3333 (50 lines.)

COVENTRY: 8-10, CORPORATION ST. Telegrams: Autocar, Coventry. Telephone: Coventry 5210.
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The Outlook

Back to Dunne and Junkers

FLYING history, as we have often pointed out, is full of examples of ideas which occurred to the pioneers, were abandoned for one reason or another, but were revived many years later and, with the greater knowledge gained in the meantime, achieved success.

The tailless type of aircraft is a case in point. In Germany Dr. Hugo Junkers patented such an arrangement in 1910, and about the same time Col. J. W. Dunne actually designed and built in this country tailless machines which flew from 1911 to 1914 or so. Then the tailless dropped out of the picture, and it was not until Geoffrey Hill revived the type in the twenties that any real flying was done on it.

It is interesting to reflect upon the reasons which led these early designers to attack the many difficult problems of the tailless. Hugo Junkers was mainly concerned with drag reduction. Dunne's chief aim was to attain what in those days we used to term inherent stability. Hill was of the same persuasion and wanted to avoid, or at least to soften, the stall—making it gentle and "squashy" instead of sudden and vicious.

The Junkers project never got beyond the patent stage. The Dunne monoplanes and biplanes flew quite well, were undoubtedly stable, but suffered from insufficient power, as did all the early flying machines. The Hill Pterodactyls were beginning to approach the modern stage, in which many problems that were unimportant in the lightly loaded pioneer types assumed greater proportions.

Now the pendulum is swinging back, and we are once more approaching a period of tailless experimentation. This time we are chiefly trying to improve efficiency, aerodynamic and structural. The Armstrong Whitworth glider described in this issue is a flying test bed for obtaining data on stability and controllability without the disturbing influence of a power plant and its airscrew. In America something of the same sort was done some years ago by the Northrop concern, and that firm has now progressed far enough to build a full-size bomber, also described this week.

While the flying wing is essentially tailless, the tailless design is not necessarily a flying wing. Tailless (not all-wing) designs, with nacelles for crew and power units, have rather naturally received more attention than the all-wing design which must have a very large span indeed in order to provide sufficient wing depth to house the crew, power units, passengers and the like.

It is a somewhat curious fact that whatever may prove to be the merits and demerits of the tailless at ordinary aircraft speeds, the type may be forced upon us by speeds in the sonic region. To delay the onset of compressibility it seems necessary to sweep back the wings at a very pronounced angle. This is being done on some new types, and if that has to be done the wings might as well be used for carrying the "tail" control surfaces.

It is conceivable that the coming of jet propulsion may be another good reason for trying to get away from the use of the orthodox tail. Its absence should make possible the use of multiple power units with their jets emerging fairly near the centre line of the aircraft and thus reduce the troubles associated with the cutting-out of one unit.

Atlantic Factors

IT would seem that the five Lockheed Constellations, which B.O.A.C. are hoping to put into service this year, may prove to be something of a problem for the Air Registration Board.

We have it, from what is usually termed "an unimpeachable source," that the overall load factor —or, in effect, the safety factor—for this particular version of the Constellation is 3.75 at an all-up weight of 84,000 lb. For the North Atlantic run the

weight—with nineteen passengers, which is the intended load for the service—must, at the very least, go up to 90,000 lb. This means that the factor will be reduced to the order of 3.5.

Even the U.S. Civil Aeronautics Administration will not grant unconditional clearance to the Constellation at this figure, and the situation has been relieved by the granting of "waivers"—which merely means that the aircraft has been cleared only for specified conditions. Such a practice is not favoured by our own A.R.B.

What, then, is likely to be the position over B.O.A.C.'s Constellations? In all probability the C.A.A. clearance will be validated by the A.R.B., but it seems more than a little unfair to our own manufacturers, who have built aircraft to, or above, the factors laid down by them.

Second Reading

THE squib has gone off, and it has proved to be a damp one. The much-discussed second reading of the Civil Aviation Bill took place last Monday, and, in spite of over eight hours' debate, the opposition had no effect whatever on Mr. Herbert Morrison's determination to see this Bill through without let or hindrance in precisely the same way as other stages of nationalization. No explanation was forthcoming as to how the efficiency of the three Corporations will be judged and encouraged. The Government clearly reserves complete freedom of action.

When the date of the second reading of the Bill was announced last week by the Lord President of the Council, it was clear that he intended to brook no interference with his plans. Opposition M.P.s pleaded that more than one day should be given to the Bill, but all their pleas were turned aside by Mr. Morrison, who suggested that, because the Civil Aviation Bill had been preceded by a White Paper which had been given a day's debate, there was no excuse for the second reading of the Bill itself to be debated over a period longer than one day.

Anyone who has studied both White Paper and Bill knows that the first was hardly a fair or complete precursor to the overwhelming powers of the other. The intention of the Government was clear; to nationalize at all costs, and to do so in the vague terms of the Bill—vague because of the singularly little direction which it gives, and the enormous powers which it delegates to one Minister of the Crown.

As for the debate itself, it appears to have added little to the facts already known. Mr. Morrison's opening speech and Mr. Ivor Thomas's closing one resolved themselves into a series of party platitudes, epitomized in the latter's own words "our designs for airframes were in a stage which augurs well for the future."

Opponents of the Bill found a champion in the Opposition's opening speaker, Mr. Lennox-Boyd, former Parliamentary Secretary to M.A.P., but from the outset there was little hope that criticism of the principles of this legislation could have any effect.

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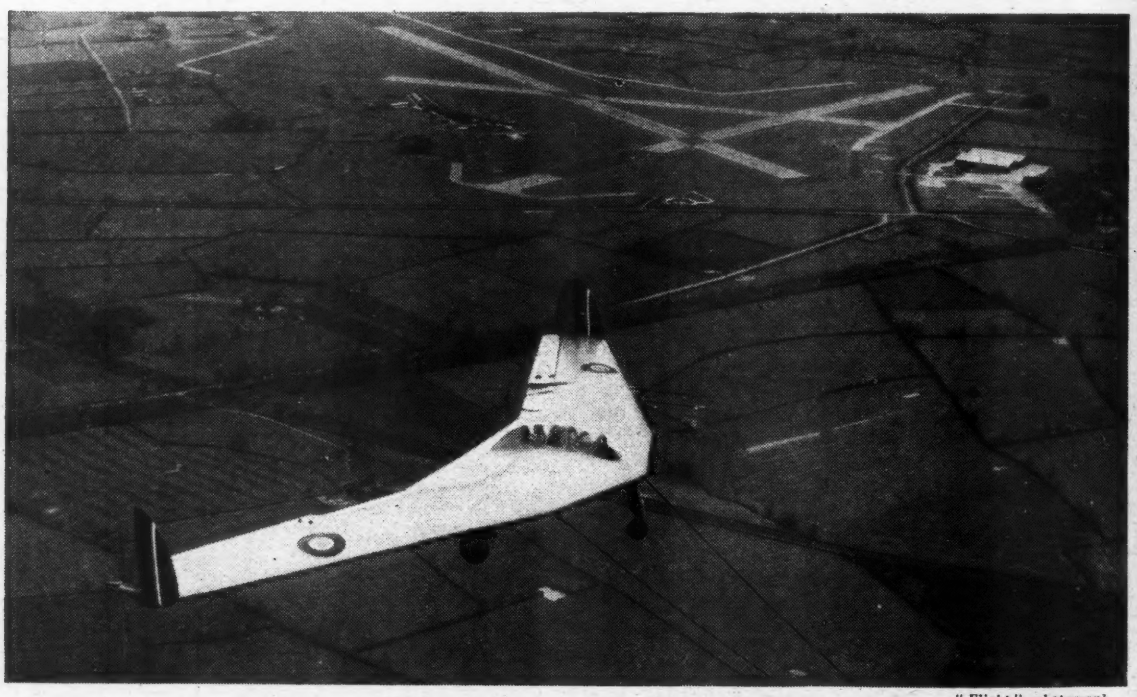
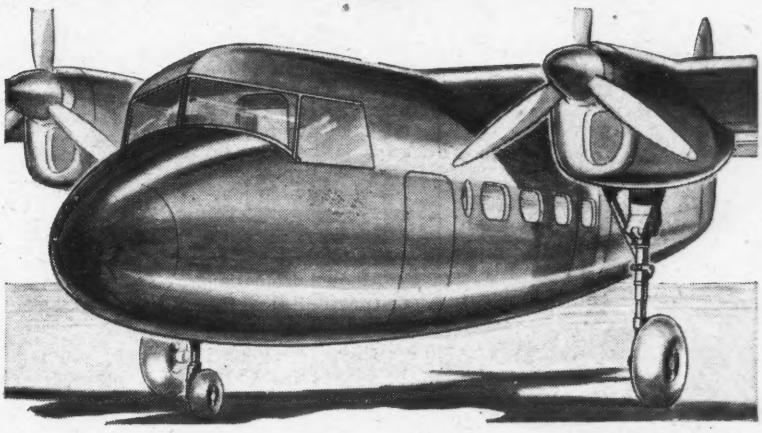


"Flight" photograph.

PRE-POWERED MODEL: The Armstrong Whitworth 52-G all-wing glider being flown from Bitteswell airfield in the Midlands. The angle of tow (known in the airborne forces as the "angle of dangle") can be clearly seen. A complete description of the 52-G appears on pages 463-468.

Percival Merganser

New Feeder-line Project : Generous Interior Dimensions : All-metal Construction



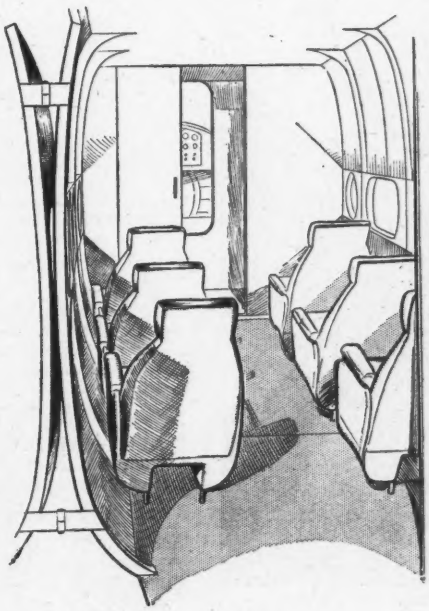
WHEN designing small and medium-sized transport aircraft there is usually a tendency merely to scale down the aircraft size as a whole, so that it becomes, virtually, a nicely proportioned replica of larger types. Often this has resulted in a certain lack of roominess for the passengers, who may be comfortable enough when installed in their seats, but who may find some difficulty in moving about. Fortunately, the feeder-line type of aircraft is not usually in the air continuously for more than an hour or two, and the lack of space should not be noticed; in any case, really ample fuselage size must usually be paid for in performance. Consequently a designer can hardly be blamed for attempting to give only bare necessities in internal volume.

A reversal of this scaling-down policy can be seen in the design of the Percival Merganser, on the prototype of which work has recently started. In this machine every effort has been made to give both passengers and crew the degree of headroom which is common only in much larger aircraft. One's first impression on entering the mock-up of the Merganser is that this spaciousness is almost excessive, but after a few moments one realizes that it is excessive only in comparison with other types of the same class. Lengths and breadths, given in figures, are not usually very expressive, and it is perhaps better to say that the interior permits a six-foot passenger to stand upright and to move about comfortably. Furthermore, it will not be necessary for the crew to contort themselves in reaching their stations, since, even in the cockpit, there is more than ample vertical space. This depth in the control cabin also permits the use of comfortably deep screens and of useful transparencies in the roof. For the benefit of those interested, the dimensions of the passenger cabin are 6ft by 5ft 6in, with 55 cu ft of space for each person.

Unlike previous Percival machines, the Merganser will be of straightforward all-metal stressed-skin construction. The layout is high-wing, with a tricycle undercarriage in which considerable ingenuity has been shown in the method of retracting the necessarily long main legs. The engines—which will be removable, with oil tanks and coolers, as units—are D.H. Gipsy Queen 51s of 296 b.h.p., and these will be mounted on simple alloy beams, each with only one radius support. The fuel (105 gallons) will be carried in four crash-proof tanks arranged inboard and outboard of the engine mountings. There will be no centre-section as such, the two-spar wings being attached directly to the fuselage, each spar root having lugs which provide a four-point attachment. Leading and trailing edge portions and the wings tips are separate units. The fuselage is conventionally constructed of frames and stringers, with a light alloy skin. It is made in three sections, with joints at the rear of the pilots' cabin and of the passengers' cabin respectively. Since the floor has been designed to take concentrated freight loads, this should also be amply strong to deal with any possible belly landing incident. Split flaps are used and both these and the undercarriage will be operated by pneumatic rams from the air supply.

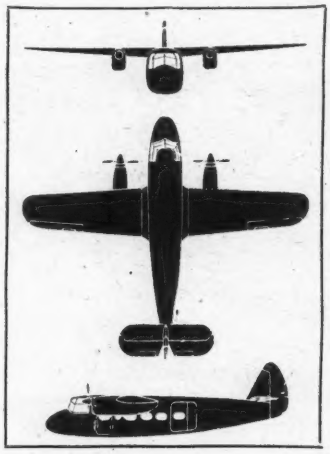
In normal form the Merganser will carry a pilot, five passengers and 300 lb of luggage. This luggage or freight allowance is high, and the cubic capacity of the standard baggage compartment, which is immediately behind the cockpit, is of a shape and size which will permit the loading and stowing of bulky packages. The capacity of this compartment is 110 cu ft, and there is 22 sq ft of floor space. There is a large outside door, opening upwards and outwards on the port side of this freight compartment, and the passengers' door, on the same side of the aircraft, opens in halves to provide additional entry area for freighter and ambulance work. When being flown as a passenger aircraft the rear portion of this door will remain locked, but the door space is still 5ft long by 2ft 3in. Stressing the fuselage to deal with the very considerable entry area must have presented an interesting problem.

The bulkhead between the passenger and freight compartments may, when necessary and between trips, be repositioned farther aft so that, after two of the five seats have been removed, the aircraft becomes a passenger-freighter. The windows are large, and the fact that the Merganser is a high-wing type should be appreciated, particularly by passengers travelling on



Some idea of the amount of headroom to be provided for the passengers in the Merganser can be obtained from this sketch of the interior of the mock-up.

comparatively low-level, short-range journeys. Incidentally, Mr. Bage, the designer, does not consider that he has lost more than 6 or 7 m.p.h. in speed by the employment of a large and practical fuselage. If this can be considered to be a correct figure, the travellers will lose just about six minutes in a 300-mile journey—minutes which they might otherwise have spent in limbering up after the rigours of a less comfortable journey.



By way of postscript it might be added in explanation that, according to the Oxford Dictionary of Current English, the Merganser is "a diving fish-eating duck." Now if it had been a flying boat. . . .

PERCIVAL MERGANSER

TWO DE HAVILLAND GIPSY QUEEN 51 ENGINES

Dimensions and Estimated Loadings

Span	47ft 9in
Length	39ft 8in
Height	13ft 9in
Wing area	319 sq ft
Wing loading	21 lb/sq ft
Power loading	11.35 lb/h.p.
All-up weight	6,700 lb
Disposable load	2,110 lb

Estimated Performance

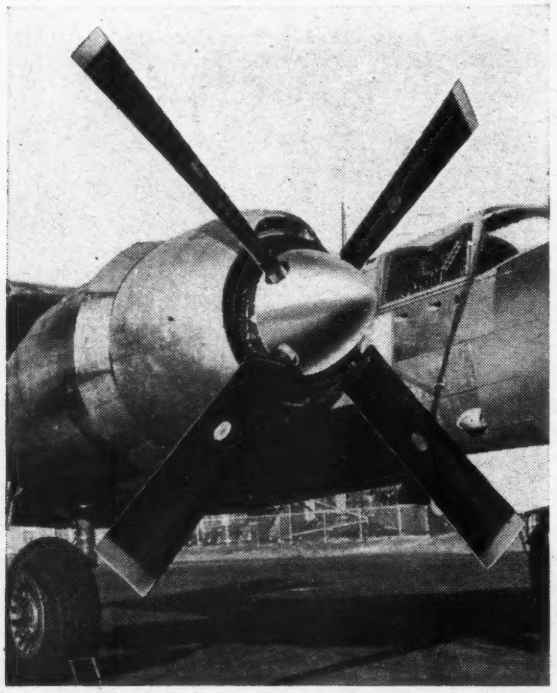
Maximum speed at sea level	180 m.p.h.
Maximum speed at 5,000ft	193 m.p.h.
Maximum cruising speed at sea level	170 m.p.h.
Maximum cruising speed at 5,000ft	183 m.p.h.
Maximum econ. cruising speed at sea level	150 m.p.h.
Maximum econ. cruising speed at 8,000ft	167 m.p.h.
Stalling speed (flaps down)	69 m.p.h.
Maximum rate of climb at sea level	1,010 ft/min
Service ceiling	24,000ft
Take-off run to clear 50ft screen	560 yd
Duration (at 5,000ft)	5 hours
Range (at 5,000ft)	800 miles

THE LATE MR. C. W. A. SCOTT

TWICE holder of the England-Australia air record and winner (with the late T. Campbell Black) of the England-Australia air race, Charles William Anderson Scott, whose untimely death at the Unrra headquarters in Germany was reported last week, joined the R.A.F. in 1922 at the age of 19 and left the Service five years later with the rank of flight-lieutenant. For the next few years he was an airmail pilot with Northern Territory Aerial Services in Australia, and it was at this period that his name came before the public when, in April, 1931, he successfully attacked the England-Australia record then held by Air Comdre. (later Sir) Charles Kingsford Smith.

In a D.H. Gipsy Moth he flew from Lympne to Port Darwin in 9½ days, beating "Smithy's" time by nearly 19 hr, and flew back to England in 10½ days, which was also a record. Incidentally, these two records were not only for light aircraft, but for any type, and in June of that year Scott was awarded the A.F.C. for "distinguished services rendered to aviation." His time for the England-Australia flight was improved upon soon afterwards, but he won the record back again in May, 1932, by a trip in eight days, 20 hr, 44 min.

The partnership with Campbell Black in the historic flight from Mildenhall to Melbourne in one hour under three days in the D.H. Comet was, of course, the outstanding performance of Scott's career, but in 1936 he was again prominent, with Mr. Giles Guthrie as co-pilot, as winner of the Portsmouth-Johannesburg Rand air race in a Vega Gull.



The latest thing from America in airscrew blade design has been devised by the Hamilton Standard concern and, as may be seen from the photograph, consists of a normal blade with a square tip. This resort is claimed to reduce tip losses and so delay the drop in efficiency at high powers and speeds.

FROM THE CLUBS

ALTHOUGH, unfortunately, Brooklands is now off the list as a possible club centre, it is hoped that flying will be started during next month at Shoreham, where the South Coast Flying Club had its pre-war headquarters. Mr. Cecil Pashley will, once again, be C.F.I., and Mr. B. S. Smallman secretary.

Naturally enough, during the six intervening years the members' register has become somewhat dated, and those interested should contact Mr. Duncan Davis at Brooklands Aviation, Weybridge.

* * *

During last week-end the United Services Flying Club started operations at Elstree, Herts, on the Watford By-pass. Pending the arrival of their own reconditioned Austers, the club is at present hiring similar aircraft. Membership is open to all who have served in any of the Services—including those of the civil variety. The club's telephone number is Elstree 1677.

* * *

As expected, the London Aeroplane Club has now reduced its flying charges to £3 10s an hour dual or solo, and the reduction from the previous figure will be made retrospectively. Tiger and Hornet Moths are used by the club, which is open daily at Panshanger, Herts, except for Monday and Tuesday. The telephone number is Essendon 305.

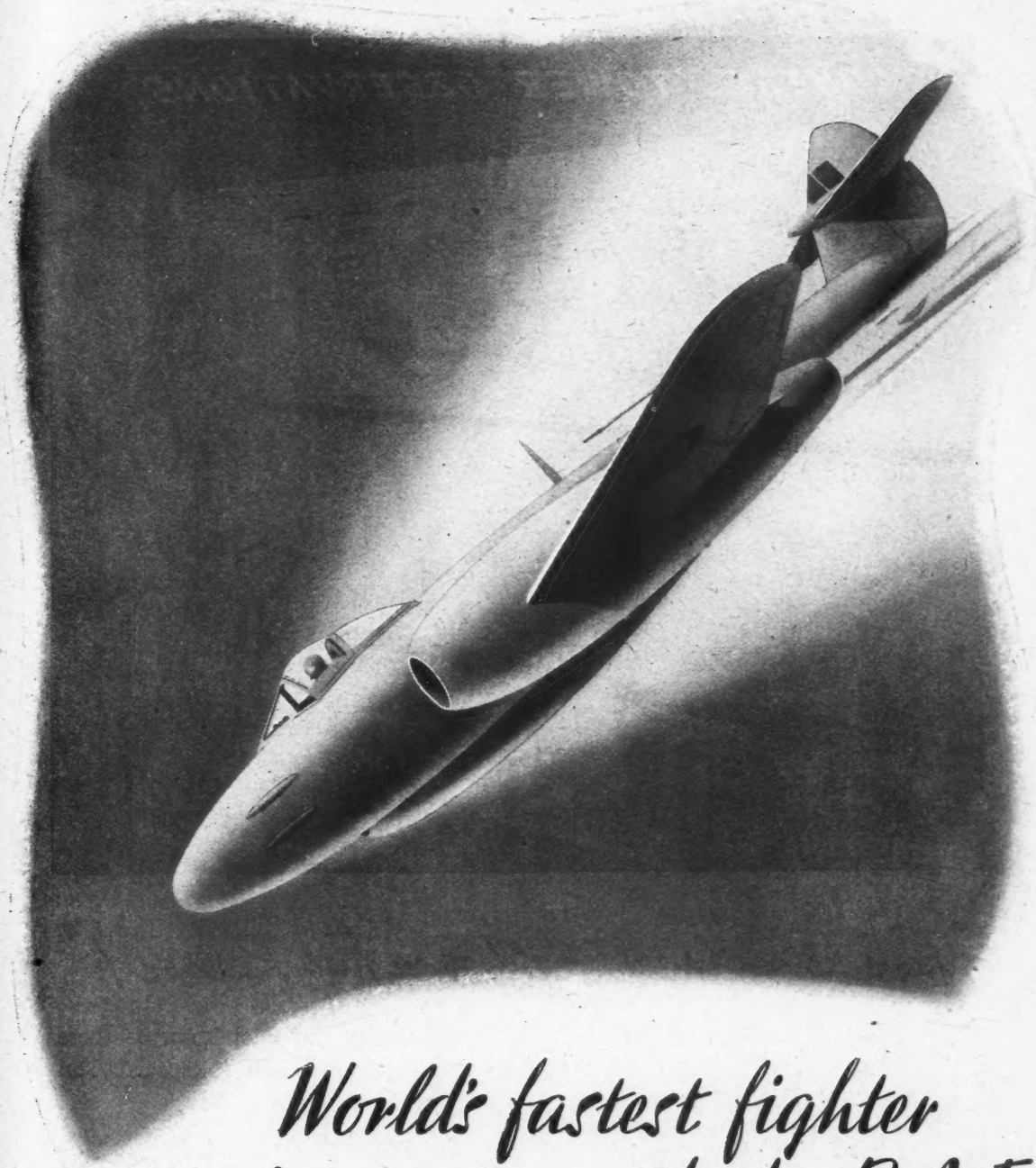
PROCTOR PRICE

FOLLOWING a rise in labour and material costs, due to the latest National Award, Percival Aircraft have found it necessary to raise the price of Proctor V to £3,300.

OFF TO ARGENTINA

THE Aircraft Division of Air Service Training, Ltd., are losing the services of their chief test pilot, Mr. Jack Storey, who is leaving to take up an appointment in the Argentine. He has been with A.S.T. since 1940, and has been occupied with development flying on American aircraft and testing repaired Spitfires.

As managing director of Hale, Hamilton and Co., of Buenos Aires, Mr. Storey intends to represent British manufacturers out there.



World's fastest fighter now in service with the R.A.F.

GLOSTER METEOR

ROLLS ROYCE DERWENT ENGINES

GLOSTER AIRCRAFT (BRANCH OF HAWKER SIDDELEY AIRCRAFT CO., LTD.)

"There he goes again—old man Fuel Reserve!"

" Yes, he's an awkward sort of passenger, old Fuel Reserve—there isn't much room for payload with him on board, especially on long-range work."

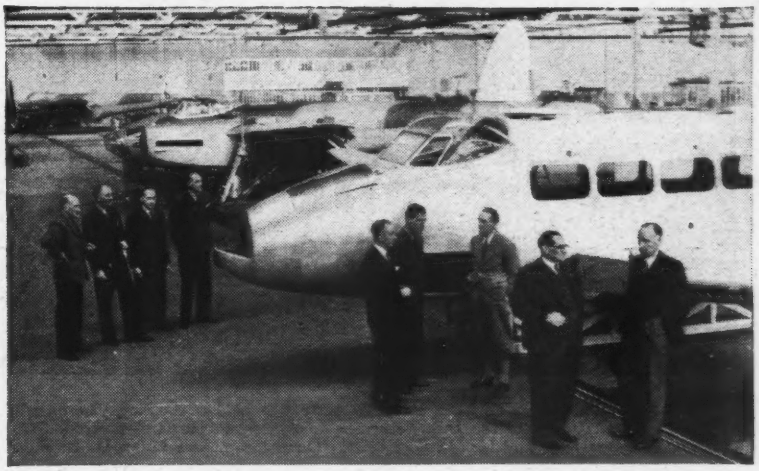
" *Just the same, he's got to be carried in case of emergencies, hasn't he?* "

" Yes—but why sacrifice payload? By refuelling in flight you can keep the best part of your reserve on the ground until it's needed —and cut out the free rides."

FLIGHT REFUELLING LIMITED

MALVERN . WORCESTERSHIRE

HERE AND THERE



FIRST AND LAST : The first production Dove follows the last Mosquito on the D.H. production line at Hatfield, though Mossie production continues elsewhere in the U.K. and abroad, well over 6,000 of them having already been built in D.H. factories alone. Sir Geoffrey de Havilland is on the extreme right.

The Bun and the Ha'penny

THE Brazilian Government has invited Britain to send a party of six undergraduates to Brazil on a three months' "good will" visit.

Not only will those lucky enough to be selected for the trip be taken by air, but the Brazilian Government is to give each of them £50 as pocket money.

African "King's Cup"

WHEN Their Majesties visit South Africa next year the Aero Club of South Africa plans to stage an air race as part of the celebrations.

Subject to the King's approval, the race will be called the South African King's Cup Air Race, and the club proposes that the finish shall be at Capetown, where the trophy will be presented.

Already the club has submitted a request to His Majesty to grant his patronage and to present the trophy to the winner.

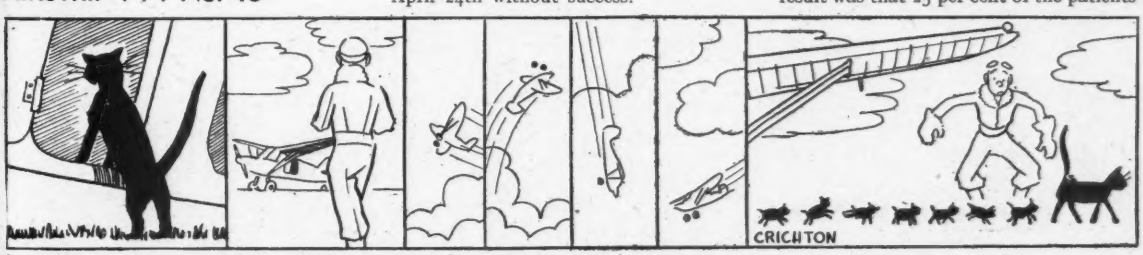
"Prudence" is Filmed

THE R.A.F.'s safety-pin-up girl, "Prudence" (who was introduced in a picture of one of Section Officer Ruth Walker's posters on this page some weeks ago) has now come to life in an instructional film, made for the Air Ministry's Directorate of Accident Prevention, which is doing the rounds of R.A.F. stations.

Miss Patricia Cutts plays the role of Prudence and the rest of the cast are all Service personnel.

Apart from flying accidents, mishaps during taxying cost the country £2,000,000 during the war, so the intensified safety campaign now being waged would appear to be amply justified.

AIRSTRIP . . . No. 13



Island's First Plane

CAMPBELL ISLAND, about 400 miles off South Island, New Zealand, was landed on for the first time by an aircraft when a Catalina of the R.N.Z.A.F. flew there recently to pick up a member of the Air Force meteorological staff who was suffering from appendicitis and urgently needing a surgeon. Both operations were completed successfully.

Landings on this island are said to be possible only in three months of the year.

Food and Flowers

A YEAR ago last week Sqn. Ldr. Harris, R.A.F., dropped the first food parcels to the Dutch people, and he celebrated the anniversary by dropping a bouquet of flowers and a letter of greeting from Marshal of the R.A.F. Lord Tedder to Queen Wilhelmina.

"On behalf of the R.A.F., I send best wishes to your Majesty and through your Majesty to your people," the letter said. "We can never forget the fine spirit shown by the people of Holland during the bitter days when your country was occupied by a hard and ruthless enemy."

Dominion Adventure

THE fact that flying can still be an adventure in Canada was illustrated recently when two brothers named Ledward were lost with their light aircraft for a whole fortnight.

They took off from Edmonton on April 15th on a flight of about 240 miles to Grand Prairie, which lies more or less under the shadow of the northern foothills of the Rockies. They failed to reach their destination and R.C.A.F. and U.S. aircraft searched for them until April 24th without success.

Then on April 29th they were found, hungry but otherwise unharmed, by boatmen on the Wapiti River, about 28 miles short of their goal. It appeared that a forced landing had damaged the undercarriage, and as the report says they were suffering from "slightly swollen feet" they had evidently been doing quite a bit of hiking.

News from Sweden

ERIK JÄGERBLOM, whose kindnesses will be remembered by many of the British contingent attending the Stockholm Aero Show in 1936, has been appointed managing director of Aero Material A/B Stockholm.

This Swedish firm, which holds the Scandinavian agency for the majority of the British aircraft firms, has also become a manufacturer in a small way. Handicapped by being unable to import aircraft equipment from Britain during the war, it produced such things as Williamson cine gun-cameras and Simmonds' computers under licence.

Rapide Cough Cure

ABOUT this time of the year it is quite usual (in fact almost inevitable) for somebody to raise the query—does flying cure whooping cough?

Strong evidence in support of the affirmative is forthcoming from Sweden (whose statistics can usually be trusted), for an experiment was recently made with over 100 young victims of this distressing complaint; they were taken for a flight in parties of eight, accompanied by eight parents and under medical supervision, in a Dragon Rapide belonging to *Svensk Flygtjänst A.B.*

The treatment consisted of a slow climb to 10,000ft, and the gratifying result was that 25 per cent of the patients

FOR THE LOVE OF PETE : An informal party was held at the Royal Aeronautical Society on the occasion of Peter Masefield, Civil Aviation Attache to the U.S., returning to America. He is seen, second from the left, chatting with (left) Mr. Geoffrey Smith, Col. Devereux and Mr. A. G. Elliott. On the right are Major G. R. Bulman, Director for Construction of Research Facilities, and Mr. S. Scott-Hall, Principal Director of Technical Development, who found in the reception an opportunity to talk "shop."

were cured completely, 50 per cent showed definite improvement, and the other 25 per cent were unaffected.

But who knows?—another few thousand feet might have done the trick!

A Busk Studentship

THERE is a vacancy for the Busk Studentship in Aeronautics for the year 1946-47, and any reader who wishes to apply should write to Sir B. Melvill Jones, Professor of Aeronautics, Cambridge University, for application forms. The trustees hope to make the appointment in June.

The Studentship, which has been founded in memory of Mr. Edward Teshmaker Busk (who lost his life in an aircraft accident at Farnborough in 1914), is of the value of about £165, and its object is to enable the holder to engage in research or preparation for research. Full details can be obtained from Sir Melvill Jones.

Parachusist's Portrait

AS a mark of appreciation of the services he rendered in training paratroops during the war, the portrait of Group Capt. Maurice Newnham, O.B.E., D.F.C., has been painted by Mr. T. C. Dugdale, R.A., at the instigation of Maj.-Gen. K. N. Crawford, then Director of Airborne Forces at the War Office, and its permanent home is to be the officers' mess at the Airborne Forces Depot and Training Centre. At present the portrait is being shown at Burlington House.

Group Capt. Newnham.

Maurice Newnham, whose name is particularly well known in motoring circles, was a fighter pilot in the 1914-18 war and rejoined the R.A.F. in 1939. After a spell on administrative duties, which he found far too static, he went to Ringway with a small R.A.F. and Army staff, and in July, 1941, was appointed to command and organize the Parachute Training School, where he himself made many jumps to demonstrate his theories and inspire confidence.

Some 60,000 parachutists were trained at Ringway, and now Newnham is writing a book, "Ringway Saga."

HERE AND THERE

Russian Riddle

LAST week there was news of yet a third act of aggressiveness by Russian fighter pilots against a U.S. aircraft.

According to reports from Vienna, two Soviet fighters dived on the B-17 used by Gen. Mark Clark as his personal transport, though the Commander of the U.S. Occupation Forces in Austria was not on board at the time.

Apparently no shots were fired on this occasion, but the Russian airmen are said to have "behaved aggressively" in an attempt to force the American aircraft down, and Gen. Clark duly lodged a protest with the Soviet authorities.

After two previous incidents of a similar nature, when shots were actually fired, the Soviet authorities apologized and undertook to see that nothing of the kind occurred again, but in any case such behaviour towards recent comrades-in-arms is difficult to understand.

News in Brief

THE Prime Minister and Mrs. Attlee, who have been invited to visit Australia and New Zealand this summer, plan to leave Britain by air towards the end of July.

* * *

Maj. Gen. Arthur Wilson, of the U.S. Army, has been made European director of Trans World Airlines, one of America's "big three" overseas operators.

* * *

Marshal of the R.A.F. Sir Sholto Douglas flew from Gatwick Airport last week to take up his duties as C.-in-C. of the British Zone in Germany in succession to Field-Marshal Viscount Montgomery. He flew direct to Berlin.

* * *

By special permission of the Royal Aero Club, the Schneider Trophy was taken by air to Vienna to be shown at the R.A.F. Austria's recent celebration of the 28th anniversary of the Royal Air Force, attended by over 500 guests, in the historic Schönbrunn Palace.

* * *

The Old Cranwellian Association is to hold its annual reunion in the Royal Air Force College on Saturday, June 15th, and members are requested to communicate with the honorary secretary at S.H.Q., Cranwell, for details.

* * *

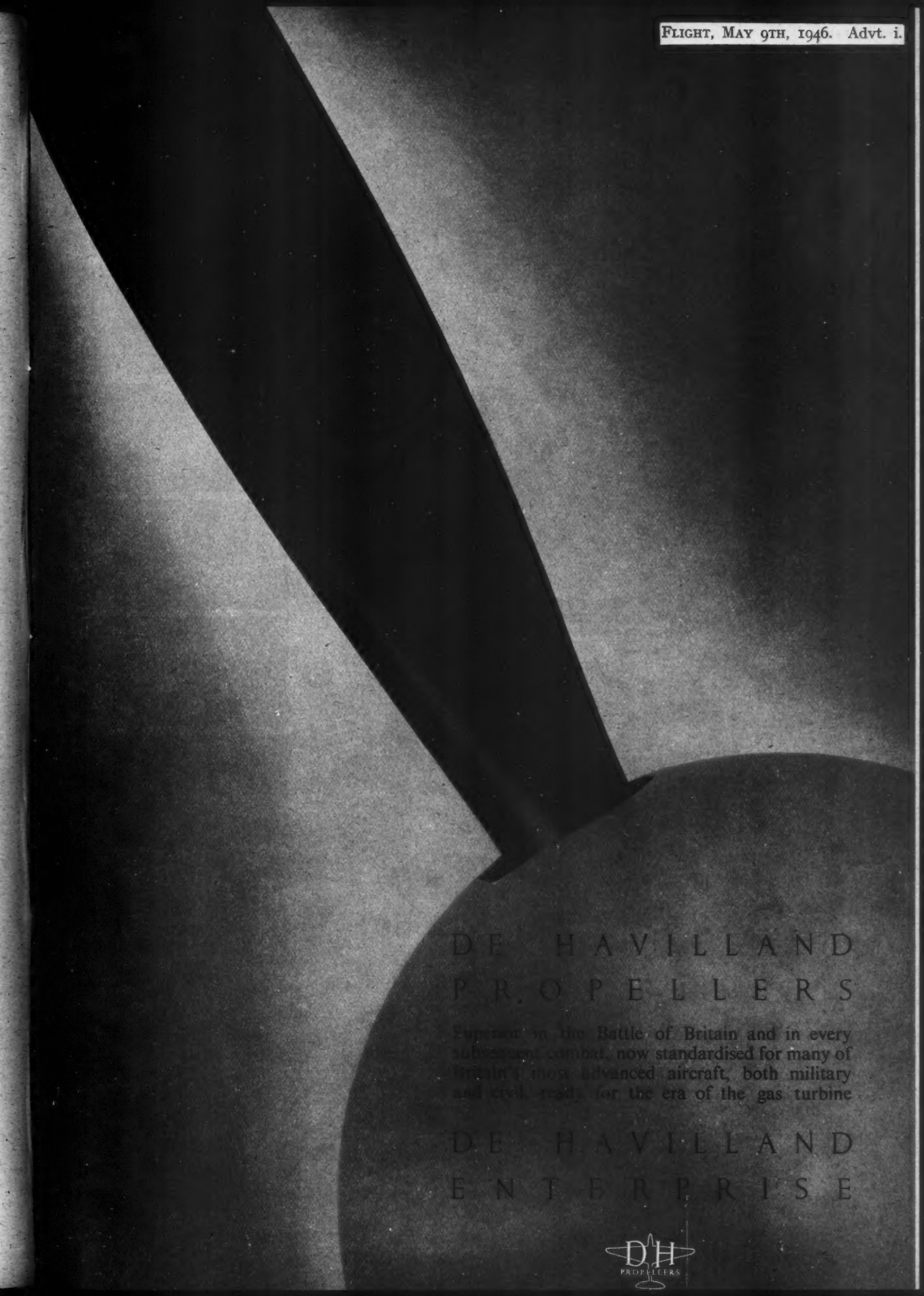
R.A.F. aircraft found a motor fishing vessel, missing for three days, drifting about 20 miles off the Welsh coast near Bardsey Island. It had been sailing from Carnarvon to Barmouth with two men aboard and was flying a distress signal from the masthead. The aircraft directed lifeboats to the vessel by dropping flares at regular intervals.

* * *

Jordan's register last week recorded the formation of a new private company—de Havilland Propellers, Ltd., with a nominal capital of £250,000 in £1 shares. The directors are Sir Geoffrey de Havilland, Mr. F. E. N. St. Barbe, and Mr. W. E. Nixon, of the de Havilland Aircraft Co., Ltd.

* * *

Twenty pilots of Air France, most of whom served in French squadrons with the Allied Forces during the war, came to England recently on a six-day visit under the auspices of the British Council. Their programme included B.O.A.C. headquarters, London Airport (Heathrow), a Transport Command airfield, and a number of aircraft factories.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PROPELLERS
Superior in the Battle of Britain and in every subsequent combat, now standardised for many of Britain's most advanced aircraft, both military and civil, ready for the era of the gas turbine
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THE STEEL
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"THE EYES OF THE ARMY"

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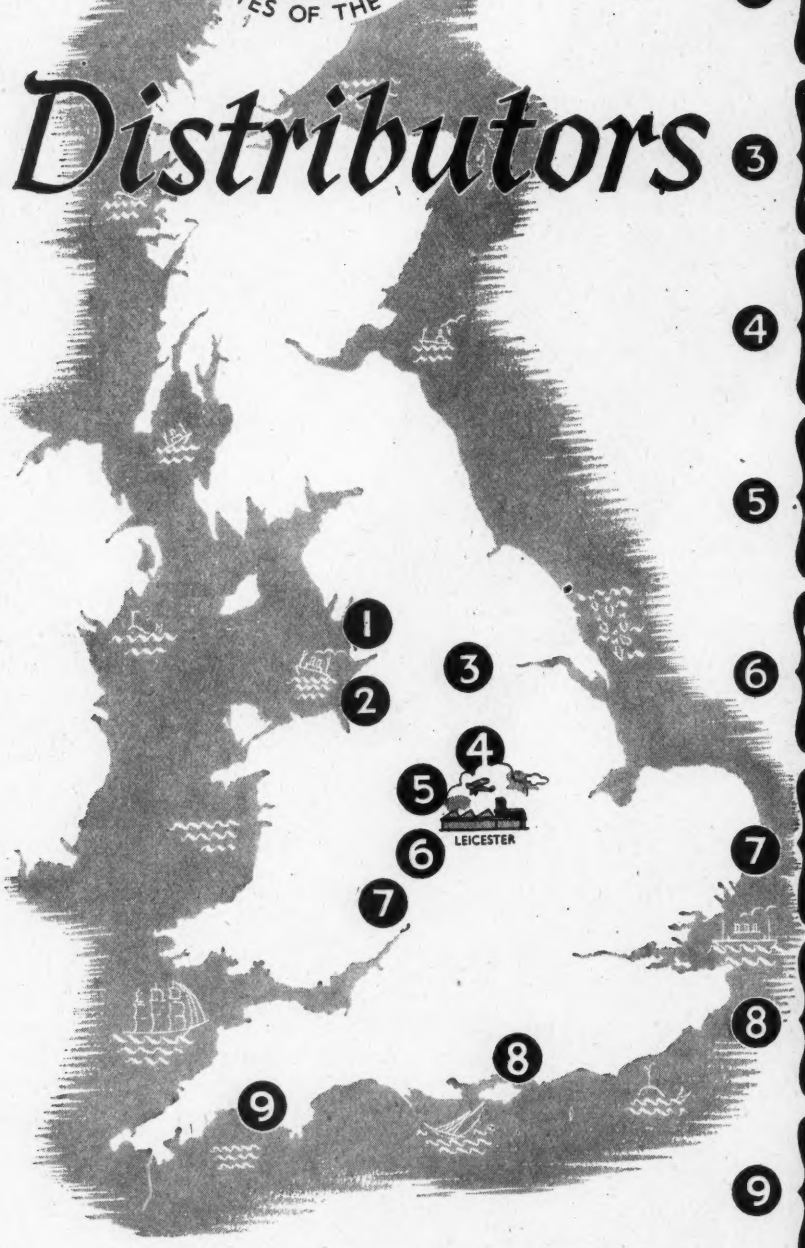

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AUSTER AIRCRAFT LTD., LEICESTER, ENGLAND.

The A.W. Flying Wing

"Flight" photograph

Experimental A.W.52G Glider: Novel Control System : Large Civil and Military Designs Foreshadowed

FLYING wing and tailless aircraft have never so far passed the experimental stage, but this does not indicate a lack of interest on the part of designers, for as long ago as 1910 fairly successful tailless aircraft had been produced by Col. Dunne in this country and by Junkers in Germany. Examples, following the Great War, are found in a number of designs built by Lippisch and, more recently, another German all-wing series produced by the Horten Brothers. In 1940, the American Northrop company built an attractive and fairly successful little powered all-wing design, the N-1M, forerunner of the XB-35, and now appears the Armstrong Whitworth 52-G glider.

Following a flight on the 52G, the Whitley tug pilot F. R. Midgley (left) is seen at the nose of the aircraft with Messrs. R. O. G. Boothe, E. G. Franklin (glider pilot), and W. W. Barratt (observer).

"Flight" photograph

The main advantage of tailless designs is the reduction in structural weight and air resistance occasioned by the absence of tail units and supporting structure. However, much of this advantage is lost by the tailless as opposed to true flying-wing design when a central nacelle is provided to house the crew and payload, and other nacelles are provided for the power units.

Unfortunately, in order to obtain

"Flight" photograph.

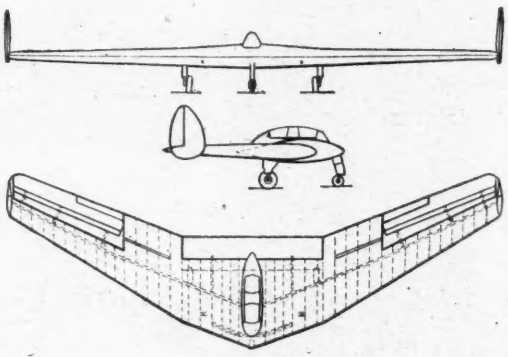
The glider sits like a kite behind its tug and is towed by a yoke attached to hooks below and just behind the leading edge.

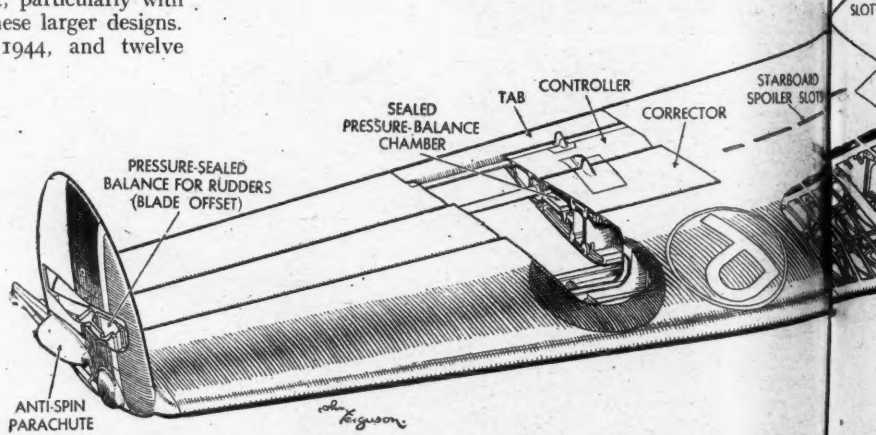
THE A.W. FLYING WING (CONT.)

sufficient depth efficiently to house engines, crew and fuel in the wing, a very large span is required. In fact, it has been estimated that, to provide an economical wing internal capacity, the minimum all-up weight will need to be not less than 280,000 lb. This has tended until recently to handicap the development of such designs.

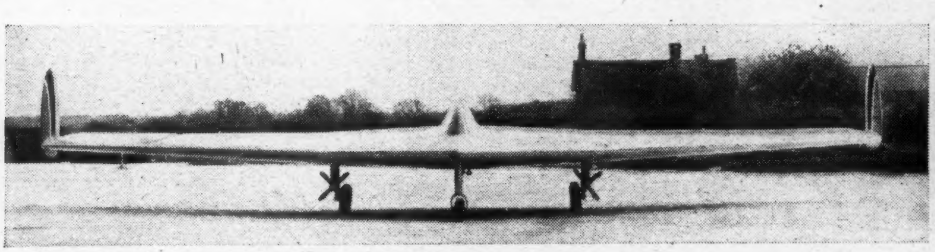
The A.W. 52-G, on which design work commenced in May, 1943, is a very near approach to the true all-wing aircraft, and only the enclosure to the pilot's and observer's cockpits projects outside the wing profile. It is purely a small-scale experimental machine produced for the study of design characteristics of much larger aircraft for commercial or military work. In layout, particularly with regard to controls, it is similar to these larger designs. Construction started in March of 1944, and twelve months later, almost to the day, on March 2, 1945, the aircraft was taken up on its maiden flight. Since that time the glider has completed 22¼ hours of towed flight and 12¾ hours of free flight. Most of the flying was done by Mr. Charles Turner-Hughes, but more recently Mr. E. G. Franklin has taken over the work.

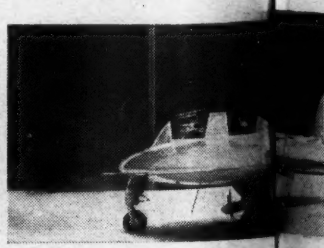
In view of the limited internal capacity of small flying-wing designs (i.e., with a span of less than 250ft) intermediate-sized tailless projects may also appear with short central nacelles and, perhaps,





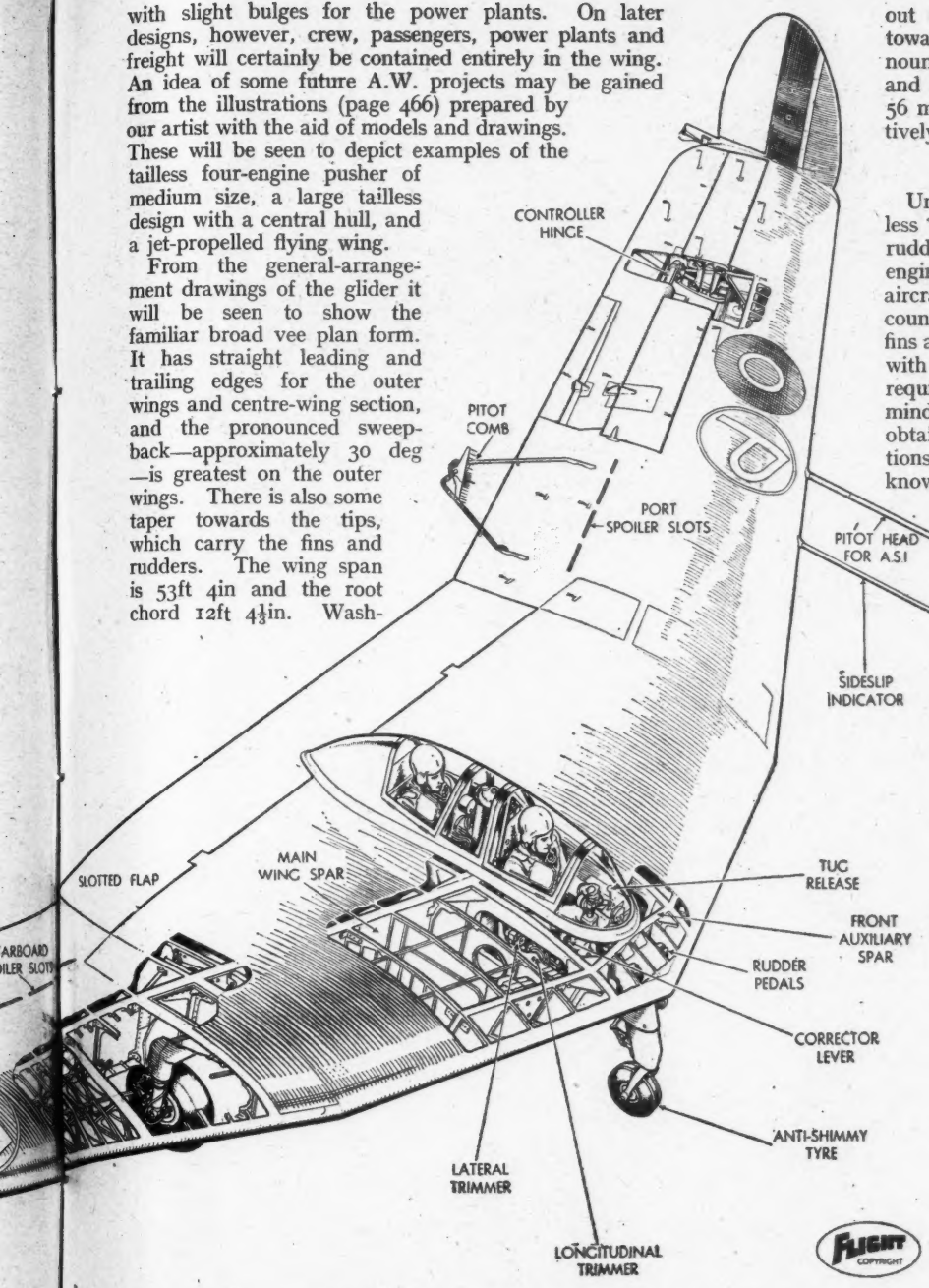
CHIEF among the many novel features of the two-seater Armstrong Whitworth 52-G is the control system. The layout of the pressure-balanced rudders and controllers and the linkage for the correctors is





with slight bulges for the power plants. On later designs, however, crew, passengers, power plants and freight will certainly be contained entirely in the wing. An idea of some future A.W. projects may be gained from the illustrations (page 466) prepared by our artist with the aid of models and drawings. These will be seen to depict examples of the tailless four-engine pusher of medium size, a large tailless design with a central hull, and a jet-propelled flying wing.

From the general-arrangement drawings of the glider it will be seen to show the familiar broad vee plan form. It has straight leading and trailing edges for the outer wings and centre-wing section, and the pronounced sweep-back—approximately 30 deg—is greatest on the outer wings. There is also some taper towards the tips, which carry the fins and rudders. The wing span is 53ft 4in and the root chord 12ft 4½in. Wash-out (decrease in angle of incidence towards the wing tip) is not pronounced for a tailless type, the root and tip incidences being +0 deg 56 min and −2 deg 19 min respectively.



shown in the cut-away portions of the drawing. Automatic photographic recording equipment is carried in the wings beside the cockpits of this experimental glider.

Rudders and Fins

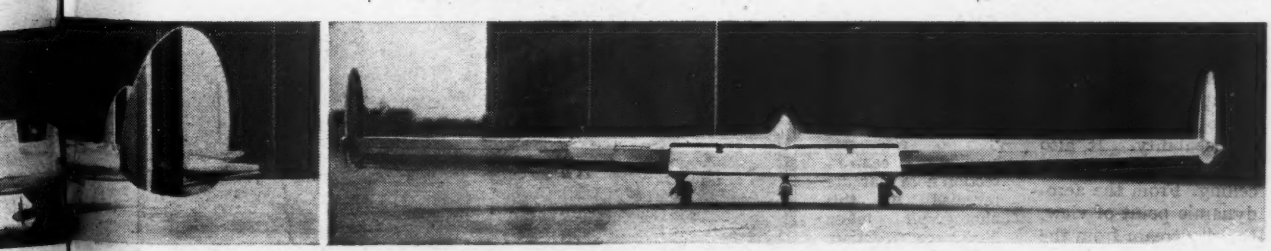
Under favourable conditions tailless aircraft can be flown without rudders, but in the event of an engine failure on a multi-engined aircraft the resulting yaw can only be counteracted efficiently by sizeable fins and rudders. The glider is fitted with fins and rudders with the requirements of the larger aircraft in mind. A great deal of data can be obtained from wind tunnel observations with models, but insufficient knowledge is gained with regard to general handling and controllability. This applies particularly to tailless aircraft.

Designs for the future may be expected to have a greater sweep back, up to a maximum of 45 deg, and down-swept wing tips may again be considered, although this at once introduces wing-tip ground-clearance difficulties.

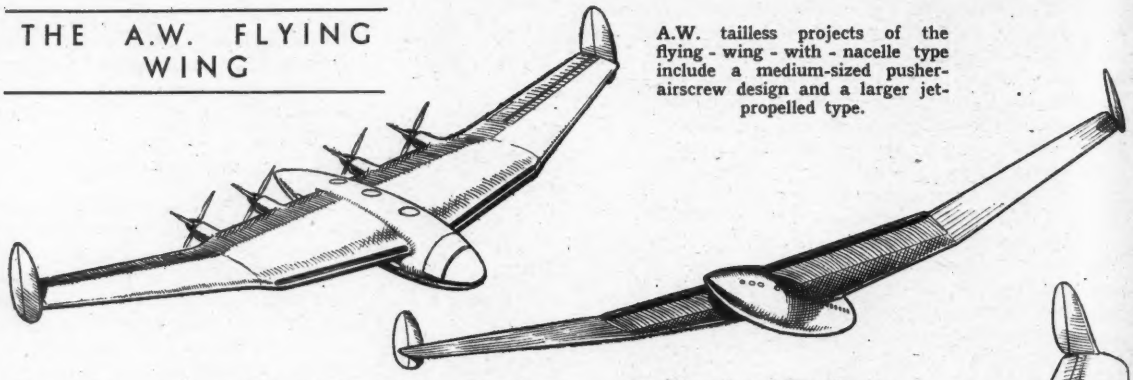
Compact tandem cockpits for pilot and observer have a single neat enclosure to give sufficient depth for seating. Using parachutes as seats the crew is housed in the wing up to shoulder height; the enclosure can therefore be shallow. Hoods hinge on the starboard side with emergency releases.

Cockpit Layout

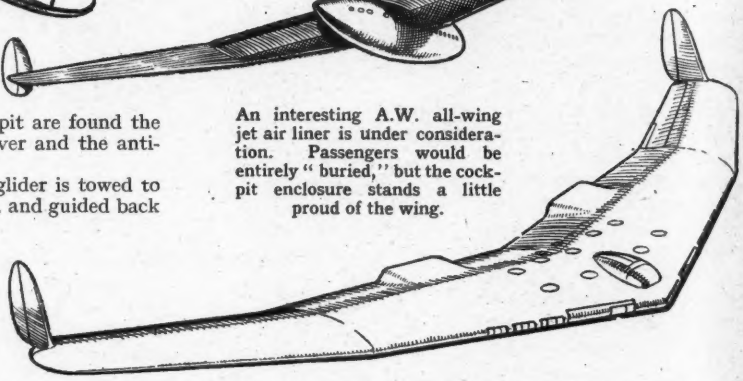
The pilot's controls are conventional; in addition to stick, rudder pedals, flap lever, and lateral and fore-and-aft trimmers, he has, on the starboard side, a large control resembling a car hand-brake lever, for positioning the hydraulically-operated "correctors." A pneumatic brake lever is provided on the control



THE A.W. FLYING WING



A.W. tailless projects of the flying-wing-with-nacelle type include a medium-sized pusher-airscrew design and a larger jet-propelled type.



An interesting A.W. all-wing jet air liner is under consideration. Passengers would be entirely "buried," but the cockpit enclosure stands a little proud of the wing.

column and on the port side of the cockpit are found the hydraulic hand pump, the tug release lever and the anti-spin wing-tip parachute release.

When a test flight is to be made, the glider is towed to about 12,000ft behind a Whitley, released, and guided back to base by its pilot. The glide takes only about twenty-five minutes, but with the aid of automatic recorders a great deal of information is obtained in the time. Sixteen mm automatic cameras are mounted in the wing roots on each side of the cockpits and these, at intervals, record instrument readings and measurements. This compact type of movie-camera recording apparatus was developed by the Hawker Branch of the combine and a description was given in *Flight* of May 18th, 1944. In addition to the recorders a battery of manometers is mounted in the observer's cockpit, together with the usual flight instruments. Photographs of the glider show the position of the pitot comb, carried well inboard behind the port trailing edge.

A controller or elevon showing the balance plate, rubberised fabric sealing material, and part of the spring unit.

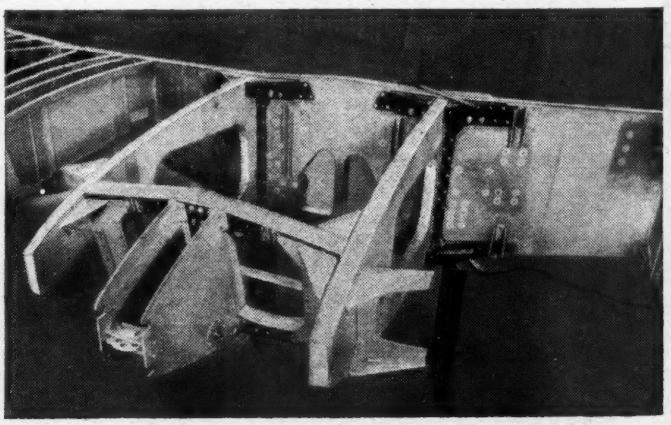
The tricycle undercarriage of the glider is fixed and brakes are provided. The nose wheel is non-steerable and carries a non-shimmying Marstrand tyre.

Armstrong Whitworth's chief designer, Mr. John Lloyd, had a number of good reasons for the choice of a glider as the small-scale experimental prototype of his various projected designs for jet-propelled flying-wing aircraft. Not only would the time taken to design and build a powered scale model have been greater, but the fitting of an engine or engines introduces extra weight and complication, and might be a probable cause of frequent unserviceability. It also places a limit on the ceiling. From the aerodynamic point of view, the slipstream from the airscrew of a tractor installation would upset the airflow over the aerofoil surfaces, while a pusher installation would normally entail the use of an extension shaft for the airscrew and, what is perhaps more important, would make the pilot's chance of baling out successfully a very slender one.

Relatively little was, or even now is, known about the behaviour of flying-wing types at and near the stall, or in unusual attitudes, and in view of their sensitivity to trim and c.g. position, no test pilot can be blamed for a reluctance to experiment with extreme conditions when his chances in an emergency are so small. Because of this difficulty explosive blade-shedding airscrew hubs have been the subject of experiment in Germany.

In construction the glider is quite conventional and with the exception of its Plymax skin is all of wood. A single box spar of spruce and ply supports the wing structure and in the central nose section a short auxiliary front spar is provided. The ribs are also of spruce and ply and the whole framework is covered with Plymax ply-light-alloy bonded sheet. Rigidity and an excellent finish have been achieved with the use of this product. The surface of the laminar-flow wing (basic N.A.C.A. 65, 3, 0, 18) is smooth, and the profile variation with changes of humidity is only just appreciable.

On conventional aircraft the large leverage of the tail-



The wood construction of ribs and auxiliary centre-section nose spar are revealed in this photograph taken during construction.

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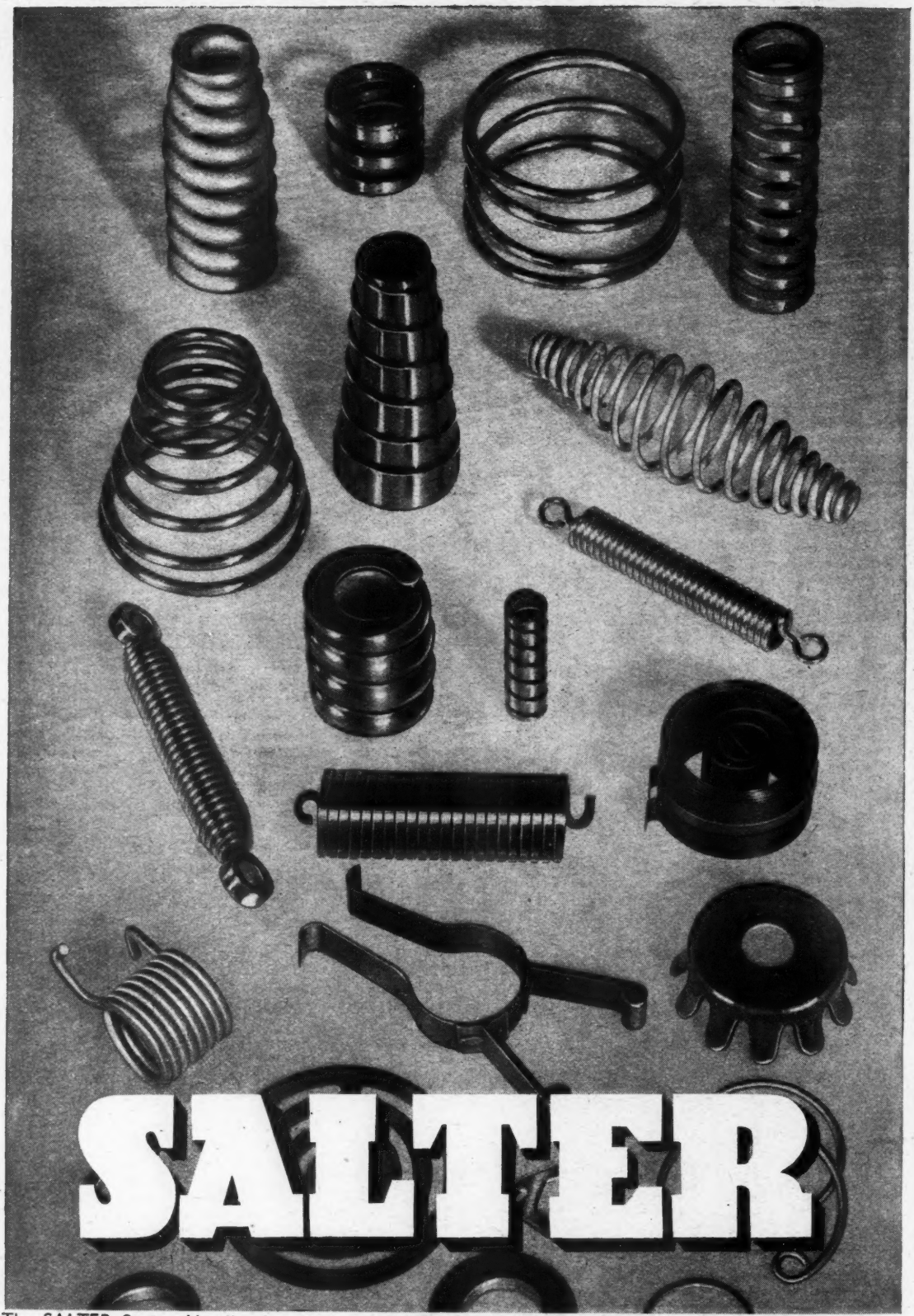

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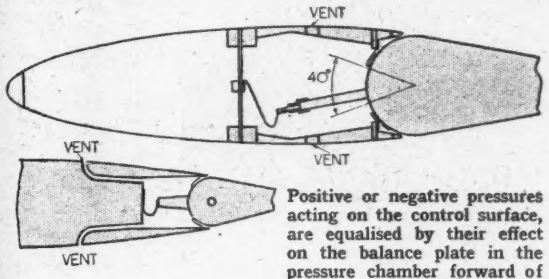
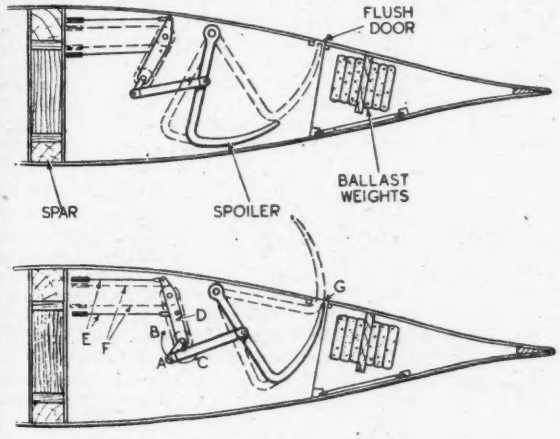
THE A.W. FLYING WING



Positive or negative pressures acting on the control surface, are equalised by their effect on the balance plate in the pressure chamber forward of the pivot point. Above, is the rudder, and left, the controller layout.

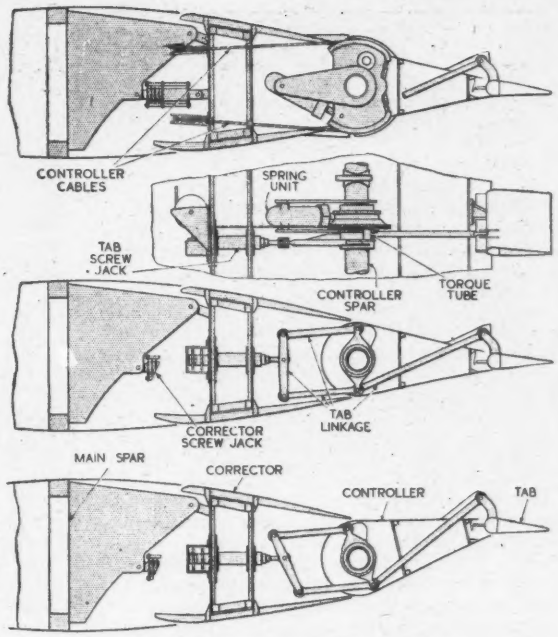
plane and elevators makes it possible for relatively small surfaces to give adequate fore-and-aft control. On flying-wing designs, however, the horizontal control surfaces need to be larger by comparison because they must be attached to the wing trailing edges where they operate with relatively small leverage. In addition, these controls must fulfil the functions of both ailerons and elevators. In order that the pilot shall be able to operate large control surfaces without undue effort an unusually efficient balancing system is needed. In addition, in view of the sensitivity to fore-and-aft trim, the design of the balances must be such that the aircraft shall have reasonable longitudinal stability.

Perhaps the chief interest in this little aircraft lies in its control system, which embodies some very novel ideas, the subjects of several patents taken out by Armstrong Whitworth and Mr. Lloyd. The special horizontal controls are chiefly concerned with the fore-and-aft stability of the aircraft, and with the counteraction of the relatively large nose-down pitching moment caused by the lowering of flaps or elevators on a flying-wing type. Two features are specially to be noted, namely, the extra horizontal control surfaces, the "correctors," hinged behind the main spar



The corrector (E) and aileron (F) circuits are interconnected for spoiler operation. The small lever at (A) lower diagram, chain-operated from the aileron circuit, moves to position (B) for "spoilers in" and to (C) for "spoiler out." The large lever (D) is moved to the operative position (lower diagram) by the correctors. The flush door in the wing upper surface is at (G).

on each wing, and, in addition to these and supported by them, two pressure-balanced combined aileron-elevators, known as "controllers." (The term "elevon" has also been applied to such surfaces.) The correctors are hydraulically operated and the controllers



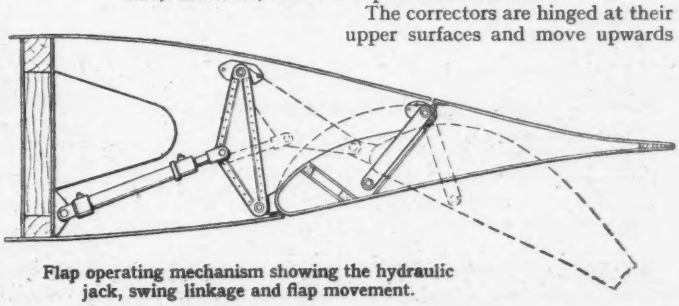
The corrector-controller-tab assembly. The tab linkage and interconnection with the corrector screw jacks are particularly noteworthy. The hinge point and jacks for the corrector which moves upwards only, are indicated. Note the pressure plate and seal on the tabs.

manually operated in a conventional manner. In the event of power failure, the aircraft can be landed safely with the use of the manually operated controllers. In this manner the problem of providing the pilot with a practical and balanced control system has been solved.

Dealing first with the pressure-balanced controllers; these are quite normal in outward appearance and take up about three-quarters of the trailing-edge span of each main outer wing. A balance plate attached to the control extends forward of the pivot-point into a compartment in the supporting member. This compartment is known as the "pressure chamber" and is divided into two parts by the balance plate. There are three flexible air seals made of rubberized fabric, attached between the front edge of the balance plate and the front of the chamber, and between the upper and lower rear edges of the chamber and the adjacent portion of the control. The layout is illustrated above.

Ducts or ports lead from the upper and lower compartments of the pressure chamber to points on their respective wing surfaces, so that pressures or depressions existing on either side of the wings and acting upon the control surfaces are reproduced on the corresponding side of the balance plate in the pressure chamber. Pressure loading on the controller is thus balanced about its hinge points, and the degree of balance depends mainly on the positioning of the ports in the wing surfaces. On the glider, the controllers are pivotally mounted on the correctors, which also, therefore, house the pressure chambers.

The correctors are hinged at their upper surfaces and move upwards



Flap operating mechanism showing the hydraulic jack, swing linkage and flap movement.

THE A.W. FLYING WING

only, to counteract nose-down pitching moment. They are each operated by three screw jacks, controlled from the pilot's cockpit by a selector lever and actuated by a hydraulic jack with reduction box.

Each controller carries a trimming tab with spring unit, also operated from the pilot's cockpit in the conventional manner. The corrector-controller-tab assembly occupies approximately fifty per cent of the wing chord.

Tab Movement

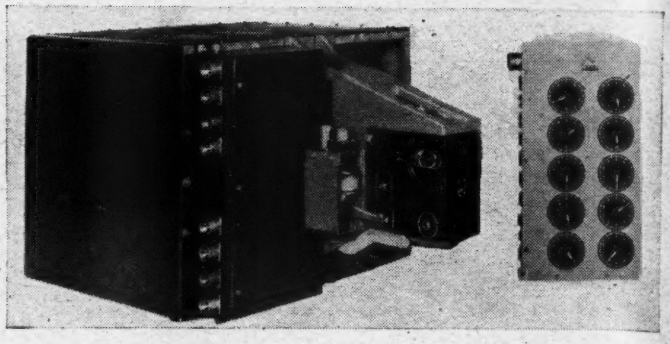
Movement of the tabs can be brought about in any one of several ways. In the first place, movement of the "elevator" trimmer causes direct longitudinal response through screw jacks and linkage by both tabs in the same sense; movement of the "aileron" trimmer through similar services gives contrary tab adjustment and therefore lateral correction; movement of the controller causes sympathetic movement of the tabs *via* the spring units, torque tubes and linkage, and, finally, adjustment of the correctors brings about a corresponding movement in controllers and tabs.

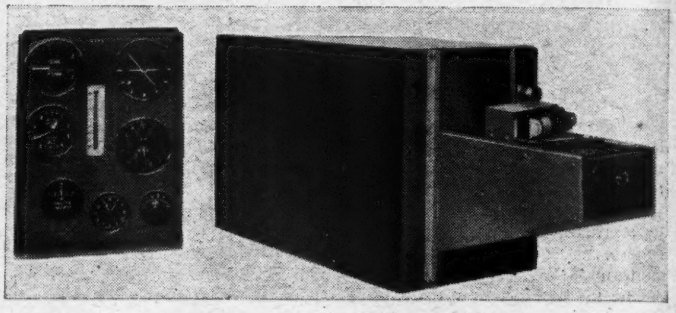
Interconnected with the correctors and controllers are two sets of spoilers, placed just inboard of the controller hinge point. They were provided originally as a precautionary measure to augment the effect of the ailerons and to counteract yaw due to aileron movement had this proved to be excessive at low speeds. They have not been found necessary on the glider, but are later to be tried out. Under normal flying conditions the spoilers would move with the ailerons, inside the wing, but, on raising the correctors, levers carrying the operating rods for the spoilers assume a new position and the upper edges of the spoilers, with ailerons in the neutral position, would be just below the wing upper surface. Transverse stick movement would now cause one set of spoilers to retract further into the wing while the other set would push open small spring-loaded doors and appear through slots in the wing upper surface. The movement is illustrated on page 467.

A single large slotted flap, with a span of 15 feet 4 inches, is operated through hydraulic jacks and swing links, and occupies the entire trailing edge of the wing centre-section. The flap is well illustrated in the heading photograph. The trailing-edges of the main outer portions of the wings sweep back from either side of the flap, the position corresponding with the knuckle point on the leading edge. The flap leading and trailing edges are quite straight and at right-angles to the longitudinal axis of the aircraft. Maximum travel is 40 degrees, the movement being downwards and rearwards on the swing links. For take-off about 10 degrees of flap is used and for landing about 30 degrees is sufficient. The movement is illustrated on page 467.

A.W.52-G DATA

Total span	53ft 10in
Height	8ft 4in
Length	19ft 4in
Wheel track	13ft 9in
Wing area	443 sq ft
Root chord	12ft 4in
Chord at mid-controller	6ft 7in
T/C at flap tips	18.76 per cent
T/C at wing tip	16.00 per cent
Incidence at wing root	+ 0 deg 56 min
Incidence at wing tip	− 2 deg 19 min
Dihedral outboard of knuckle	6 deg 5 min 12 sec
Controller area	20.5 sq ft
Corrector area	18.8 sq ft
Trimmer area	2·46 sq ft
Fin area	11.1 sq ft
Rudder area	5.6 sq ft
Flap area	57.5 sq ft
Weight with crew	6,000 lb
Wing loading	13.46 lb/sq ft
Max. speed	250 m.p.h.
Landing speed	65 m.p.h.





For quick recording of readings specially designed automatic 16 mm photographic recorders are carried in the wing centre section. The components are illustrated above.

Directional control is obtained through wing-tip fins and rudders of conventional appearance and, although trimming tabs were originally fitted, these have now been eliminated. A straightforward double linkage looks after the differential movement. Considerable use is made of the rudders, as ailerons have very little turning effect on flying wing aircraft, and an increased flying range is said to result from the use of the former type as opposed to drag rudders of the kind favoured by German designers of all-wing aircraft. The pressure-balanced control, as used for the controller, is equally suited for use as a rudder; the vents, however, are positioned rather differently with relation to the pressure chamber as shown in the illustration on page 467.

Flight Characteristics

It is not possible to test a glider in quite the same way as a powered prototype in that the short periods of free flight must be used to make as many observations as possible. It is not economical for the pilot to fly around and get used to the glider as he would in the case of powered aircraft. On the subject of general handling, it is understood that a creditable degree of stick-free stability has been achieved and both rudder and aileron control are good. Elevators are exceptionally sensitive by comparison with the other controls, or with those on a conventional aircraft. Without flaps, the rate of descent is about 500 ft/min, but with 30 deg flap the steepness of approach and rate of descent are greatly increased. Full flap—40 degrees—is not generally required or used.

The maximum speed permitted is 250 m.p.h., the normal gliding speed is around 120 m.p.h. and the stall occurs at 60-65 m.p.h. For initial approach 100 m.p.h. is a comfortable speed and, "over the hedge," 80 m.p.h. is adequate.

The glider has a surprisingly long free-landing run after touch down at about 65 m.p.h., and, for direction, will answer quite well to controls without use of brakes until the speed is low. In towed flight it is very steady, sits high above the tug and, to an observer in the Whitley, gives a "kite-flying" impression.

Target Indicators: Marking for Small High-Priority Targets: Enemy Reactions: Master Bomber Duties: Solutions to Some Problems

PATHFINDER STORY

PART II—By Wing Commander MAURICE A. SMITH, D.F.C.

TARGET indicators used for marking an aiming point on the ground at night were, in effect, a large number of coloured incendiary candles packed in light metal bomb-like containers. The normal colours were red, green or yellow, and various burning times up to 30 minutes were available according to intensity. The fusing was under time or barometric control, and a small explosive charge was arranged to drive the candles out of the canister just before hitting the ground in order to spread them over a small area. Two sizes of T.I. were in normal usage, 250 and 1,000 lb. These figures represented the weight of a bomb of corresponding size for the bomb stations on the aircraft, not the weight of the T.I. The T.I.s were virtually impossible to extinguish, and the enemy were never able exactly to reproduce the colours in their decoy marking. "Spot fires" were another type of ground marker used for certain pin-point targets, and also for route-markers or for wind-finding datum points. Red, yellow or green spot fires, as the name suggests, give one bright, compact spot instead of a patch of brilliance as in the case of a T.I.

IN the first instalment of this account of the work of Pathfinders, the difficulty of pin-pointing at night, and the conception of Pathfinder Force were discussed. Radar aids and marking procedure were also described. In this concluding part, an account of planning, of marking for special targets, and of some of the difficulties experienced during night bombing raids is given.

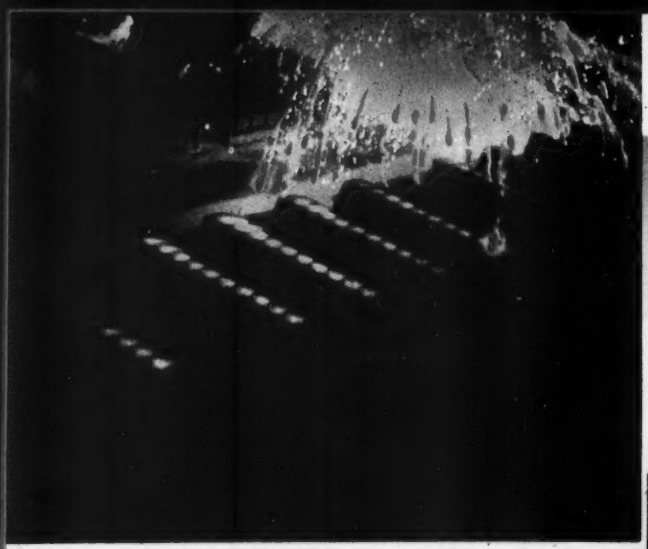
For sky-marking, small, short-burning red, yellow or green flares were fitted with parachutes giving them a very slow rate of descent, and as a distinguishing mark, "stars" of a different colour dripped from them at intervals. These, like the attacks for which they were used, were known as Wanganuis.

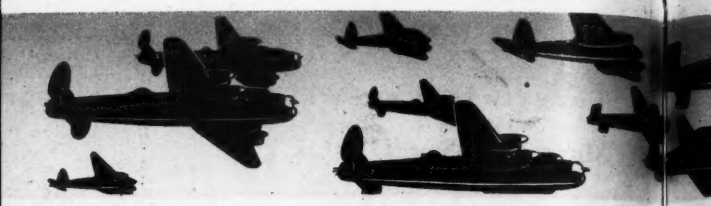
There was, of course, a good deal more to the planning of a bombing raid than the selection of marking and bombing techniques. An operational day in a P.F.F. squadron started with the preliminary warning to all, followed by notification of the target to those few responsible for planning the attack. The weather forecast was examined, and the size of the total force settled; next, depending upon the marking method to be employed, a marking team was selected, and the special stores and bombs fused and brought from the bomb dumps. The crews would next be notified and their aircraft thoroughly checked, tested and refuelled up to the capacity required for the trip (full tanks were not usually needed, and no superfluous fuel was carried). By this time every detail of the marking and attack would have been worked out and co-ordinated at a flight planning conference, and after an "operational" meal, all that was left before take-off was to brief the P.F.F. and main force crews on marking methods and colours, route, navigation, signals, defences, the latest weather and winds, special information from intelligence sources on particular methods of escape, and action to be taken if forced to "bale out." The crew interrogation and raid assessment conferences which followed each attack have already been mentioned.

As the war progressed, targets necessitating a deep penetration of German territory had to be attacked, and often the priority was such that ideal conditions could not be awaited. It therefore became customary to provide for an alternative method of attack in the event of weather being found to differ from that predicted. The enemy, too, were introducing all sorts of cunning into their defences in the form of decoy marking in open country near the target, and decoy fire sites to attract the bombs of crews harassed by flak and searchlights. Over some targets, such as oil refineries, appeared thick smoke-screens while nearby would be an elaborate dummy factory exposing a few chinks of light. Demoralising "scarecrows," in the form of large explosions resembling a bomber receiving a direct hit from an anti-aircraft shell, appeared in the air near the bomber stream, and false instructions were, on occasions, issued by radio to the crews.

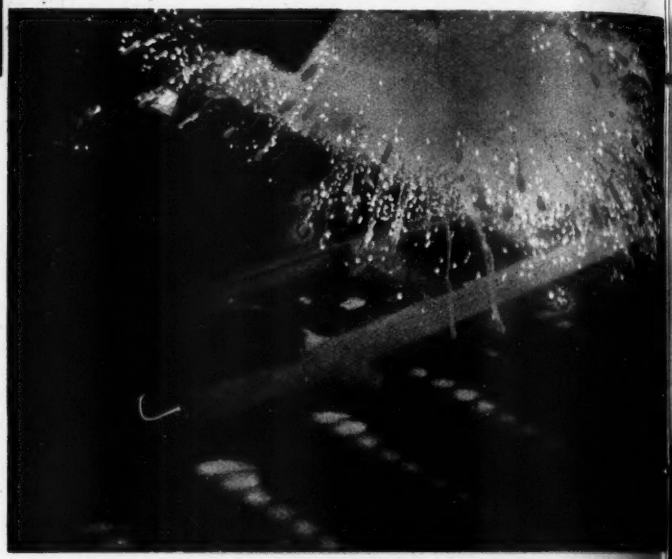
The Master Bomber

Experienced crews were not much affected by these devices, but the large number of newer crews required some direction. It was for this reason, and the need for decisions on marking and plan of attack in the target area, that the Master Bomber made a timely and logical entry. Known variously at first as Master of Ceremonies





one. As a "skipper" once remarked after a raid in the Leipzig area, "It's not always so much the instructions you notice, but the relief at hearing a good English voice getting things organised ahead of you after that long slog through flak and dirty weather." Certainly any sort of boost to morale was a good thing as the target area loomed up.



A yellow target indicator bursts just above ground level and spreads its candles over a section of the factory target to give an aiming point.

or Controller, the Master Bomber was, in effect, the personal representative of the Air Officer Commanding, in the target area. Of Squadron Commander status, he was given complete control of the attack after most careful briefing. The Master Bomber needed few special attributes except a clear head, a clear voice and an intimate knowledge of marking and bombing techniques. It has been said that "only men of proved ability, possessing the qualities of leadership, flexibility of outlook, clear judgment and capable of immediate reaction to changed circumstances, were selected for the job." Certainly, the Master Bomber had a responsible and often trying job, for he had to remain in the target area for the duration of the attack, often at a very low altitude, and regardless of the dangers and distractions of enemy defences. A Master Bomber was employed on many of the most successful attacks of the war, and after an introduction in May, 1943, took part, on the night of August 17th-18th, in the highly important raid on Peenemunde, the German V-weapon research establishment.

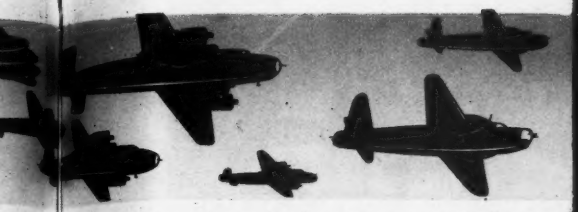
Boost for Morale

Providing all went well with an attack, the duty of the Master Bomber was, to a great extent, a psychological

Light patterns over Hamburg. Searchlights make weird traces while heavy flak shells produce beautiful palm-like flashes on bursting. On the ground may be seen the muzzle flashes from the heavy A.A. guns. Arrows indicate flak bursts, A searchlights, and B muzzle flashes.

Radio communication during raids presented ever-varying problems. From take-off until the target was reached, complete radio silence was normally observed by all aircraft. However, a W/T listening watch was kept by wireless operators, and an individual aircraft or all aircraft could be sent instructions from base; or, in emergency, they could send messages back to base. Should airfields become unfit to receive returning aircraft, diversion instructions would be given through this medium. On high-priority targets, in the later stages of the war, it was also customary for the Master Bomber provisionally to estimate the probable degree of destruction caused by the raid, and to have his assessment transmitted back to base on leaving the target, thus giving perhaps three extra hours for the planning of a repeat daylight attack should this seem necessary.

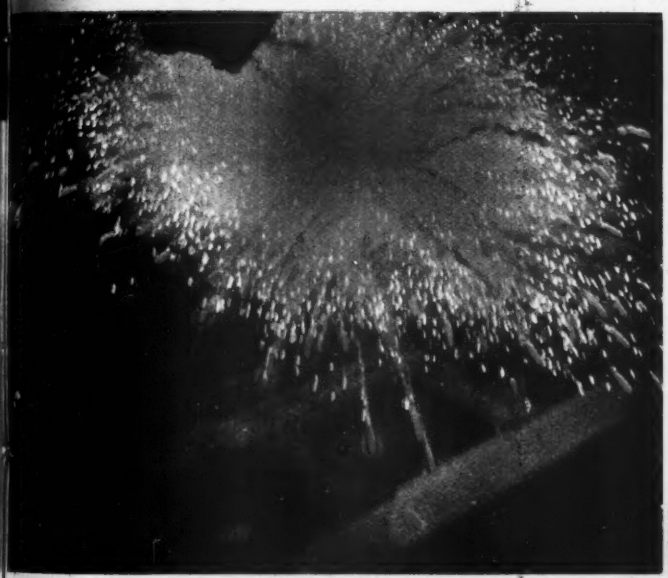
For inter-communication between aircraft or for local airfield control, H/F radio (T.R.1196) was used in Bomber Command until shortly after D-Day, when V.H.F. (T.R.1143) began to be substituted or introduced in addition. With the general introduction of V.H.F. intercommunication was greatly improved and target area control was made somewhat easier, both clarity of reception and range being increased. In the event of the primary frequency being jammed, alter-



native channels for target controlling were arranged, and radio-link aircraft were usually provided to pick up instructions on V.H.F. channels and to relay them by W/T for confirmation, or for the benefit of any aircraft with V.H.F. unserviceability. Wind vectors to be set on bomb sights were also passed in this way by specially selected crews, for the benefit of less experienced crews or those with unserviceable navigational equipment. Code words were always used to identify Main Force and Master Bomber and for important instructions such as "cease bombing" or "abandon mission." Other normal instructions were broadcast in plain language.

The marking technique normally used by No. 5 Group's Pathfinders was a modified form of Newhaven. A separate word should be said about this Group, which, towards the end of the war, was employed against specific small targets such as flying-bomb sites, canals, marshalling yards, and especially oil refineries. For such compact targets, extreme accuracy and concentration of bombing was required over a small area, otherwise only repairable damage instead of complete obliteration resulted

Illuminating flares slowly sink and burn out as the first loads of incendiaries fall across the target, at zero or "H" hour for the attack.



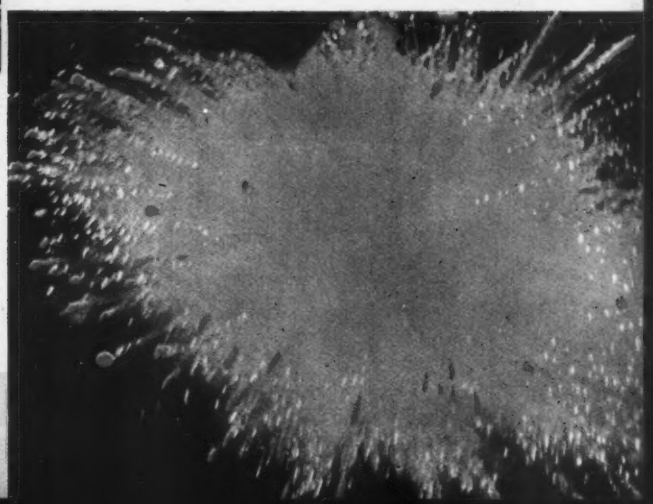
Inaccuracies would mean also that many bomb loads would be wasted on open country, and a second visit necessitated.

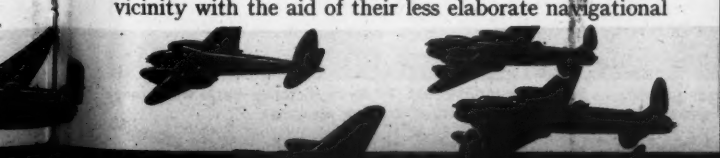
To the bombers overhead, T.I.s appear as a small splash of colour made up of tiny but brilliant pinpoints of light, partly smudged by smoke.

The marking scheme was a mixture of the visual and blind techniques, and both Mosquitoes and Lancasters took part. Primary Blind Markers, using instruments alone, first dropped green T.I.s as proximity markers as near to the target as possible. Mosquito Markers, and the Master Bomber and his deputy, who had arrived in the vicinity with the aid of their less elaborate navigational instruments, flew to this datum marking, which was followed, after a short interval, by long sticks of illuminating parachute flares, released across the target. The first flare-wave crews, who "dropped blind," were of Primary Blind Marker status, and the visual flare-wave crews, who followed, were less experienced, and used the early marking as a guide. By the light of the flares, at low level, the Mosquito Marker crews, who had spent the day memorising the target area from photographs, searched for the pre-determined marking point and using a dive-bombing technique, placed a red or yellow T.I. on this point. The accuracy normally achieved was between 100 and 200 yards. After assessment by the Master Bomber, the T.I., if accurate, was backed up by others as required. The Main Force was then given its bombing instructions, or, rather, confirmation of them, by the Master Bomber. Unless complications arose, the full briefing given before take-off enabled the crews to attack according to the primary plan. The Master Bomber was present at this stage chiefly to supervise, to ensure the accuracy of marking, and to deal with emergencies.

More Aids to Navigation

Towards the closing stages of the war, more aids in the form of special navigational instruments made their appearance in P.F.F. aircraft. These included the A.P.I. and G.P.I. (Air Position and Ground Position Indicators) which, after setting, worked automatically in conjunction with the D.R. (Distant Reading)





compass and the A.S.I. (Air-Speed Indicator) to give latitude and longitude positions for the aircraft.

Another device, "Loran" (Long-range Aid to Navigation), was also produced. This was an American radar grid navigational system somewhat similar to Gee, introduced as a result of pooled Anglo - American knowledge and requirements. The ground equipment consisted of pairs of stations, master and slave, situated about 400 miles apart, which radiated pulses continuously. The aircraft carried a receiver, and a cathode-ray tube indicator to measure the difference in time of arrival of corresponding pulses from the two ground stations. The maximum range of Loran, which was intended in particular for the Japanese war theatre, was in the region of 1,500 miles on sky waves ("E" layer reflection) and 800 miles on ground waves over sea, with less over land. The use of sky waves was normally limited to night flying. Considerable skill was required of navigators to select the correct pulses, but the range of Loran made it very useful on night operations in the European theatre when deep penetration of German territory was called for.

PATHFINDER STORY—*continued*

Some Problems and Solutions

It is appropriate to mention a few of the marking and bombing problems successfully solved on night operations and certain questions come to mind at once. For example why did not fires, smoke and bombing obliterate the marking when an attack started? This did at first occur, but was later prevented in various ways. First, for an attack of long duration, a succession of Pathfinder waves were provided to back up or re-mark as dictated by requirements during the course of the raid. Secondly, the marking point could be chosen at the up-wind edge of the target, and aircraft briefed to run in down-wind. This had the advantage of giving a view clear of smoke, and a fast passage through the heavily-defended area; however, it reduced the period for the bombing run, and tended to hurry the bomb aimer, especially in poor weather conditions. On certain attacks, the marking point could be brought as much as half-a-mile up-wind of the target, and the crews briefed to delay bomb release by a predetermined number of seconds, on a fixed heading, after the marking had passed across the bomb-sight graticule. An alternative to this "overshoot" method of bombing was the vector method, for which a calculated false bombing wind was set on the bomb-sights so that bombs aimed at an off-set marker would actually fall on the target.

Another question which might be asked is how, in an attack on a city, crews avoided placing an over-concentration of incendiaries in one area at the expense of another. This problem was solved by briefing crews or squadrons to attack on a number of different headings with varied short periods of delay before release of bombs and after sighting. Aircraft thus fanned out and dropped their loads evenly over the target. To avoid collision risks, crews on different headings were also briefed to take different height bands at the target.

Beginning of the End

Once it was within the power of Bomber Command to hit and destroy in one blow any known target in enemy territory, the defeat of Germany was unmistakably foreshadowed. The devastating effect on the morale of the German people on seeing their important cities relentlessly destroyed is still to a great extent incalculable. With the participation in round-the-clock attacks by the American Air Forces and other commands of the R.A.F., the realisation must soon have come that eventual defeat was inevitable.

If, in spite of our determination to preserve peace, there are to be wars in the future, it is improbable that an active Pathfinder Force in anything like its World-War form will be resurrected. Radio (including radar) control of pilotless aircraft or other projectiles from home bases appears to be the next stage of development. Pathfinder Force of Bomber Command will, therefore, be associated for all time with the 1939-45 War against Germany, and future historians will endorse the present belief that Bomber Command, more than any other single force, was responsible for the ultimate defeat of Nazi power.

As an incendiary attack is completed and aircraft turn for home, a rear gunner sees fires begin to take hold. White incendiaries merge with orange and red flames, and heavy black smoke from oil tankers in the marshalling yard, starts to billow upwards.

Northrop Activities

Details of the XB-35 Flying-wing Bomber : F-15 Reporter Photo-Reconnaissance Development

ALTHOUGH American manufacturers generally are noted for their enterprise, none is better known in this connection than the Northrop Company. President of the corporation, John K. (Jack) Northrop, has pioneered many novel and advanced designs, and as long ago as 1923 he toyed with the flying-wing idea. In 1928 he built a small aircraft of flying-wing conception but having twin booms to support tail surfaces. Recent examples to appear include the N-1M all-wing flying scale model, which completed 200 flights before honourable retirement, and the XP-56, first American tailless, pusher fighter. The Black Widow, to mention a rather more conventional aircraft, is believed to be the first aircraft specifically designed as a night fighter. It was used with success in the East in the later part of the war and was also in limited use against flying bombs at home. Its controls were of particular interest.

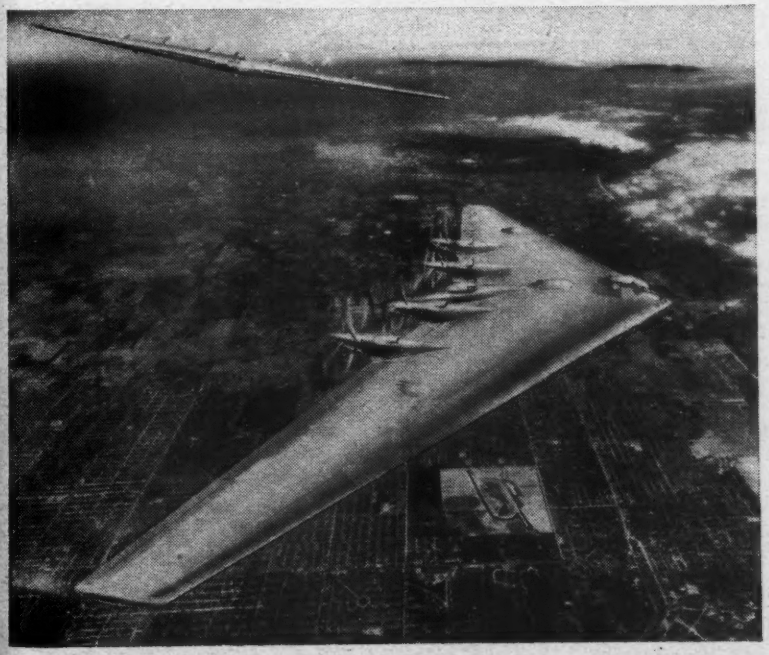
In producing the XB-35, first large-scale flying-wing bomber, the Northrop Company have drawn on many years' experience of such types, and in particular upon information obtained from the N-1M and from four 60ft scale models produced for study of flight characteristics. Construction of the full-scale aircraft was commenced in January, 1943, and it was completed and wheeled out for engine running, etc., some two weeks ago. The design was originally submitted in September, 1941, and work on a preliminary contract on a cost-plus-fixed-fee basis started in 1942. The cost of the first aircraft is estimated at $13,000,000.

A new aluminium alloy known as Alcoa, said to be stronger than previous materials of a similar nature, has been used in the construction of the XB-35, which has a dry weight of approximately 89,000 lb and a designed useful load of 73,000 lb. The overload gross weight is expected finally to be 209,000 lb.

Developed from the Black Widow, the Reporter differs chiefly in its engine cowlings and cockpit enclosure.

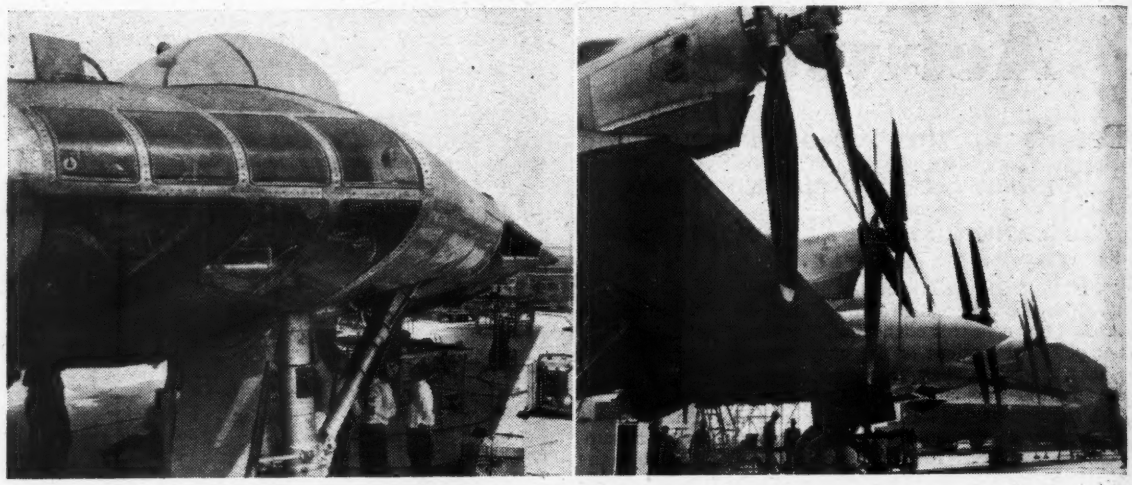
Of roughly boomerang shape, the bomber has a span of 172ft and a wing area of 4,000 sq ft. These figures make an interesting comparison with those for the Boeing Superfortress, largest operational bomber to date, which has a span of 141ft. and a wing area of only 1,739 sq ft. The root chord of the flying wing is 37.5ft and at the tips the planes taper off to 9ft 4in. A tricycle undercarriage is fitted, with dual main wheels of 5ft 6in diameter, and a nose wheel 4ft 8in diameter.

As reported last week in *Flight*, when a first photo of the XB-35 was published, the power is provided by four Pratt and Whitney 4-row radial Wasp Majors, each producing a full-power rating of 3,000 h.p. Eight-bladed counter-rotating pusher airscrews of Hamilton Standard type are driven through extension shafts and are capable of pitch reversal for braking. The engines are entirely contained in the wing and characteristically each is equipped with two single stage turbo-superchargers. Cooling and intake air is collected through



An artist's impression of the XB-35 bomber in flight. Some idea of the armament and the finished appearance of the faired-in extension shafts and airscrew spinners may be gained.

NORTHROP ACTIVITIES (CONTINUED)



Two recent close-ups of the XB-35 reveal (left) the offset cockpit bubble, transparent nose and a section of the leading-edge air-intake ducts. On the right are seen the pairs of four-bladed co-axial airscrews without their fairings or spinners. Figures in the foreground lend perspective to this 104-ton bomber.

long duct in the leading edges and taken through plenum chambers where the forward motion of the aircraft builds up pressure. It seems strange that a high-speed high-altitude flying-wing bomber so eminently suited to gas turbine engines should have large, heavy, complicated piston engine installations. Presumably this is due to the fact that no suitable jet units are at present available in America.

XB-35 DATA

Span	172ft
Height	20ft 1in
Length	53ft 1in
Wing area	4,000 sq ft
Root chord	37ft 6in
Tip chord	9ft 4in
Design weight (empty)	89,000 lb
Design weight (loaded)	162,000 lb
Overload weight	209,000 lb
Elevon span	34ft 6in

Engines

Pratt and Whitney Wasp Majors	(2 x R-4360-17, 2 x R-4360-21)
Normal power	2,500 h.p.
Maximum (military) power	3,000 h.p.
Dry weight (less air scoops, gear boxes, shaft, etc.)	3,295 lb
Airscrew clearance	9ft 8in

Airscrews

8-bladed Hamilton Standard Super-Hydromatic, diameter	15ft 4in

Controls on flying-wing types are always of interest, and the Northrop Company are known to have developed a special servo-system. Elevators and ailerons are combined in a single elevon and are operated in the normal manner by the pilot who is, however, assisted by a powerful hydraulic power-booster interconnected with a pneumatic "feel" device. Eight hydraulic pumps are employed and together they absorb 92 h.p. The pneumatic system applies appropriate loading to the controls to give normal balance.

The rudders resemble double split-flaps on the trailing edges near the wing tips. They operate on the drag principle and there are no vertical control surfaces. The hydraulically operated landing flaps occupy the centre portion of the wing trailing edge and are each 29ft long and some 6ft wide.

Slots, normal in operation, are provided in the wing leading edges. These contribute to safe handling near the stall, but interrupt the clean surface of the wing and serve no useful purpose at higher speeds. Special doors have therefore been designed which open automatically at low speeds, but at high speeds close over the slots and restore the smooth wing contour.

An unusual A.C. electrical system is employed to reduce installation weight. With the exception of the controls most other services, turrets, bomb doors, landing gear, etc., are electrically operated. Four engine-driven alternators supply the 400-cycle, three-phase, 208-volt A.C. circuit.

A modified Minneapolis-Honeywell automatic pilot (Elmer in America) has been developed for the XB-35 which employs four (i.e., one extra) servo motors and is rather larger than the standard type.

The active crew of the bomber comprises nine men—pilot, bombardier, navigator, engineer, wireless operator and turret gunners—and in-wing cabin space is provided for six more reliefs for long operations.

Few details of the armament of the XB-15 are as yet available; however, two turrets are situated midway in the wing top surface, outboard of the engines, and a four-gun turret is located in the dorsal position. To the rear of the dorsal turret there appears to be a fire-control cupola, and the streamlined fairing extending from it beyond the trailing edge in the centre probably houses defensive armament.

The Northrop F-15 Reporter

To meet requirements in the Pacific area the design of the F-15, modified P-61 Black Widow, was commenced in mid-1944. Known as the Reporter, this photographic-reconnaissance aircraft has a range of 4,000 miles, a ceiling of 35,000ft and a top speed in the region of 440 m.p.h. Of particular interest is the cockpit enclosure, which is among the largest free-blown bubbles ever produced.

Six cameras can be carried, and twenty-four optional arrangements permit eleven different types of mounting. The crew sit in tandem, and either member can pilot the aircraft or operate the cameras. Foure and aft armour plating is provided, and below and behind the cockpits is carried a 500-gallon fuel tank.

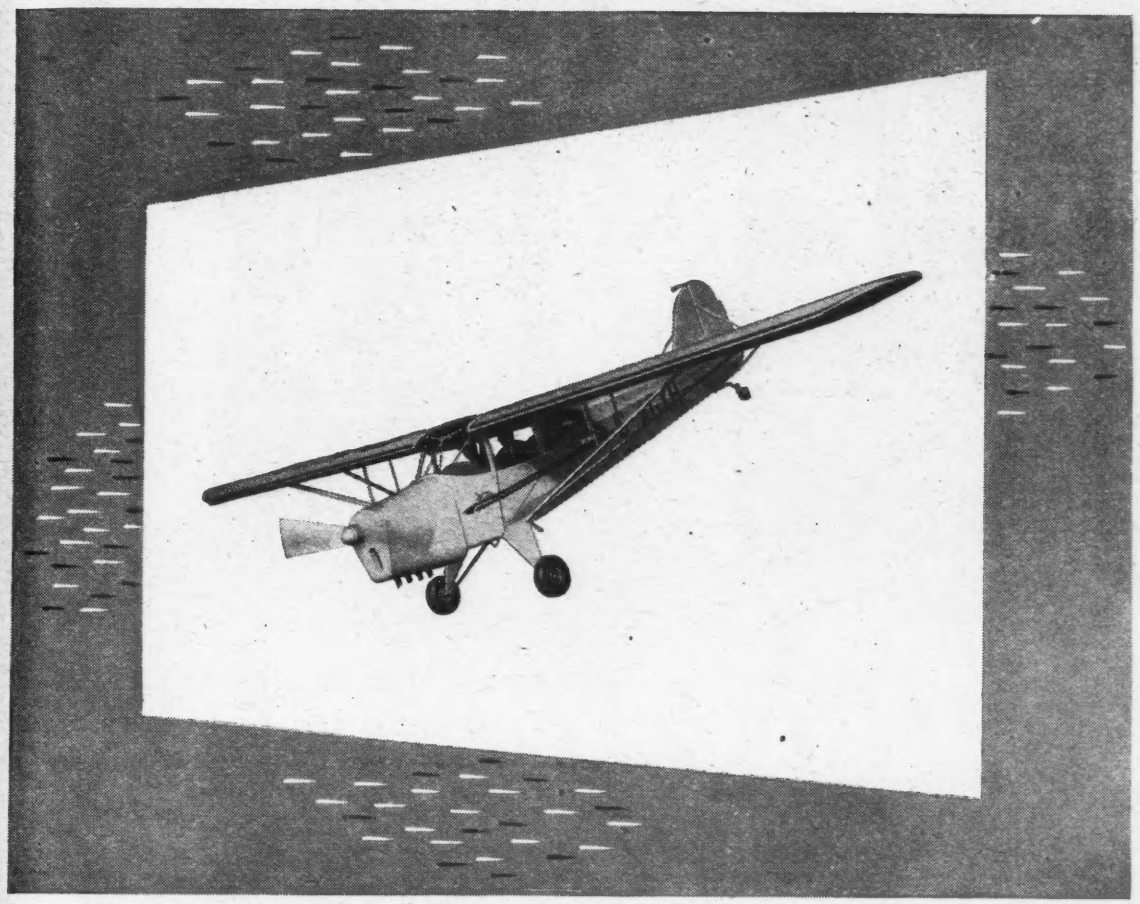
An interesting feature which, together with the full-span landing flaps, helps to give the F-15 its good low-speed manœuvring and landing characteristics are the retractable ailerons which move into the trailing edge of the wing.

Pratt and Whitney R-2800-C engines with special broad-bladed 12ft 8in diam. Curtiss electric airscrews are fitted. They have turbo-superchargers and develop 2,100 h.p. for take-off. The span is 66ft, the length 50ft 3in, and the weight 28,000 lb.

HONOUR FOR PROFESSOR SOUTHWELL

BRITISH aviation circles will applaud the award, by the Institution of Civil Engineers, of the James Alfred Ewing Medal for 1945 to Professor R. V. Southwell, M.A., LL.D., F.R.S., for specially meritorious contributions to the science of engineering in the field of research.

Professor Southwell, now Rector of the Imperial College of Science and Technology at South Kensington, was closely connected with aviation in the early days. After serving with the R.N.A.S. and R.A.F. on non-rigid airship work, he became superintendent of the Aerodynamics Department at the N.P.L.



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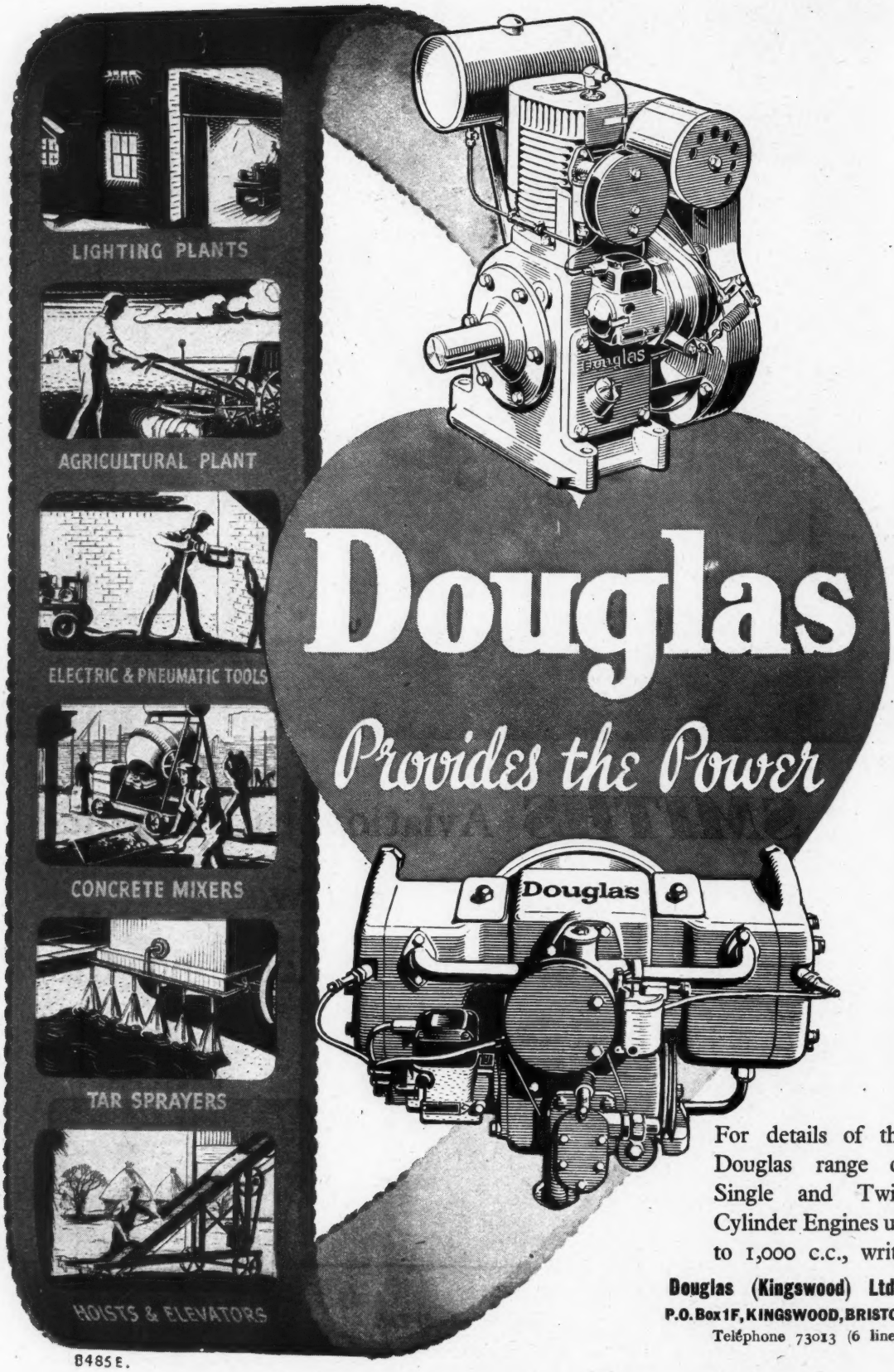
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CIVIL AVIATION

BACK AGAIN

THE British South American Airways Lancastrian, *Star Land*, commanded by Air Vice-Marshal D. C. T. Bennett, arrived back at London Airport last Sunday evening at the conclusion of its survey flight to, and across, South America. The purpose of the flight was to investigate possible extensions to the present B.S.A.A. schedule.

ROUND DOZEN

B.O.A.C. has ordered twelve Short Solent flying boats, through the ubiquitous Ministry of Supply. These are for use on the Far Eastern service on the run between Singapore, Hong Kong, and Shanghai. This order is in addition to one placed earlier for Sandringhams, but these will now be Sunderland Vs. It is suggested that, by the time the Solents are in service, Tudor IIs may be available for other sections of the Empire routes.

Meanwhile, the first of the five Constellations has been delivered to the B.O.A.C. handling party in the United States.

ATLANTIC INCREASE . . . .

LAST week we mentioned that the transatlantic air service of Trans-Canada Air Lines had been increased to four times weekly. It now appears that T.C.A. aim at improving the service still further to five flights each way in the very near future, and that the target for July is one flight a day in each direction. At present Lancastrians are used on this service, but in due course the company will employ the Merlin-engined Skymaster for transatlantic flights. It is hoped that the prototype of this machine will fly in July and that the aircraft will be in operation before the end of the year.

A week ago Mr. F. M. McGregor, who is operations manager for the Canadian Government's transatlantic air service, visited this country. He first joined T.C.A. as its first pilot when the company was formed in 1937. During his visit he announced that Mr. C. S. Hewitt, who has for some time been T.C.A.'s station manager at Prestwick, is returning to Canada to take up an appointment at Dorval, Montreal, as base manager for Atlantic flights. His post at Prestwick will be taken over by Wing Cdr. John A. Ross, who first joined the company in 1938.

. . . . NEW SERVICE . . . .

A K.L.M. Skymaster has just completed a transatlantic proving flight to and from the United States via Prestwick in preparation for the regular service which is to begin on May 21. Two flights weekly will operate in each direction between Amsterdam and New York, and there will also be a charter flight each week between New York and Curacao. In September, K.L.M. hopes to introduce its South Atlantic service via Lisbon, Dakar and Natal.

. . . . AND RE-ROUTING

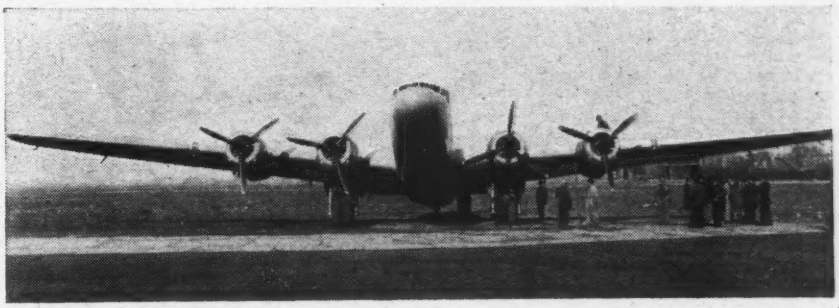
LIBERATORS of B.O.A.C.'s return ferry service which fly daily across the Atlantic are now landing at Shannon (Rineanna) on five days each week on the inward journey: From Shannon, the aircraft fly on to Hurn where the service terminates. The outward run, however, does *not* begin at Hurn; instead passengers are embarked at Prestwick, as in the past. Nevertheless, on five days each week the outward run also is routed via Shannon. These changes have been made so that crews will become familiar with the route which will be followed by the future transatlantic service.

The return ferry service will probably continue to operate for several months more, but its ultimate span of life has not yet been determined. It has now operated without a break for five and a half years, and, in over 2,000 crossings, has carried 20,000 passengers and 3¾ million pounds of mail and freight.

FLYING BOAT BASES

REPLYING to a question by Mr. Geoffrey Cooper in the House of Commons on May 1, the Parliamentary Secretary to the Ministry of Civil Aviation gave an assurance that the best expert opinion and all relevant considerations, including technical aspects, had been taken into account before any decision was made to use Southampton Water as an interim flying-boat base. Mr. Ivor Thomas added that the suggestion that the British Air Lines Pilots Association had stated that Southampton Water could never be considered as a suitable seaplane base, and that the scheme was unsafe both for shipping and for aircraft, had not been confirmed by the secretary of that Association.

The alleged B.A.L.P.A. statement was originally referred to at question time on April 18 by Sir J. Lucas after the Parliamentary Secretary had disclosed that the estimated cost of providing temporary docks and other accommodation at Southampton, to enable B.O.A.C. to use it as an interim base instead of Poole was £80,000. On that occasion, Mr. Thomas stated that he accepted the fact that Southampton Water could not be regarded as satisfactory for a permanent marine air base, but, while he was not prepared to say for how long the interim base would be used, he indicated that a permanent marine air base could not possibly be developed in less than two years. To mention a period of two years in relation to such a project seems to us to be another example of unjustifiable optimism.



SAVOIA REDIVIVUS: The first Italian civil air service to be opened, between Milan and Rome, will be operated with Savoia-Marchetti SM-95s. This is an eighteen-passenger transport powered with four Alfa-Romeo 131s. One of these aircraft has been used in this country and was seen (in the distance) at the Farnborough Display last year.

P.I.C.A.O.

AN interesting little booklet has been published by the Provisional International Civil Aviation Organization under the title—which might well have come straight from the ITMA radio programme—"What is PICAO?" This question must have been asked by hundreds of people since the organization came into being and the booklet is, therefore, all the more welcome. It contains a brief history of P.I.C.A.O., and explains the Interim Agreement, Assembly, and Council and their functions.

At the present time, the first regional conference under the auspices of P.I.C.A.O. to discuss the operation of civil air routes in the European and Mediterranean areas is in progress in Paris. The conference began on April 24 and is expected to go on for about another week. The U.K. is strongly represented by eighteen delegates, sixteen of them from the Ministry of Civil Aviation, and two from the Meteorological Office at Air Ministry. In addition these delegates are accompanied by eighteen advisers and a secretariat staff of six.

PRESTWICK AGAIN

ON Wednesday of last week various pointed and other questions were asked about the position of Prestwick as a trans-Atlantic terminal—and, in particular, in relation to the recent agreement with Eire.

Mr. Ivor Thomas explained that this agreement would have no effect on the planned uses of Prestwick, and said that it had nothing to do with the routing of services via Scotland. While Prestwick was the present United Kingdom Atlantic terminal, Rineanna was an intermediate staging post on the

CIVIL AVIATION NEWS

service between London and North America. The existing Transport Command service between Prestwick and London would, he said, be replaced by a civil air service "as soon as possible."

SOUTHAMPTON'S AIR FACILITIES

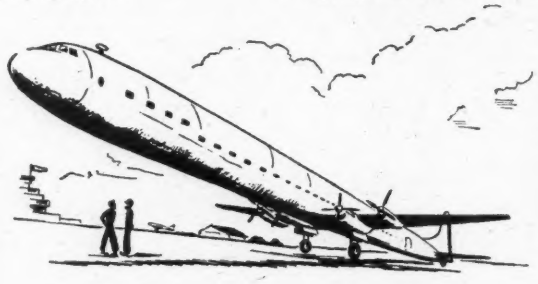
THE Southampton Airport at Eastleigh, which has now been derequisitioned by the Air Ministry, will, in future, remain open each day from 6 a.m. until dusk, with the exception of Sundays when it will open at 8 a.m. In a few weeks' time, when full night lighting equipment becomes available, night landings will be possible subject to prior notice. Hangar accommodation and 73 octane fuel are available at the airport and the airport authorities hope shortly to be able to provide 87 octane fuel as well. There are Customs facilities daily from 6 a.m. to 10 p.m.

TRANS-AUSTRALIA

THE Australian National Air Lines Commission has decided to give the Government-operating company the name of Trans-Australia Air Lines, and the first of the two Douglas Skymasters ordered by the Commission is expected in September, with a further two in October. These DC4s will be Merlin-engined, so that there will be standardization on the Pacific route; it will be remembered that Trans-Canada's Skymasters will also be so powered. The Australian policy in this matter is, in any case, one of standardization, and a Sydney factory is, we hear, being tooled up to produce Merlins.

D.H. SPARES

ALTHOUGH both the Fox Moth and the Moth Minor have been "orphaned" in this country as far as spares are concerned, it is now possible to obtain parts for both these types from two of the Dominion D.H. companies. Now that the Canadian factory is producing an improved Fox Moth there is hope of revival of servicing possibilities. At the same time, the Australian company has re-purchased a quantity of Moth Minor and Gipsy Minor spares from the R.A.A.F., and these are available at pre-war prices.



They say it's the Tudor Thirty

ANOTHER CHARTER COMPANY

A NEW air taxi concern, Kenning Aviation, Ltd., of Kenning House, Sheffield, will shortly be starting operations. At the moment the company is awaiting delivery of D.H. Rapides, for the hire of which there will be a charge of 2s 6d. a mile. One of the directors is Wing Cdr. Roy Harben, of Air Training, Ltd., Derby, and, at least for the moment, the company will use the Derby airfield as a base, passengers being picked up by car from there to home. The general idea, in any case, is to provide a door-to-door service for Midland residents.

SUNDERLAND STORY

ALTHOUGH not very recent history, the story of the delivery of two more Sunderlands to South America may have interesting repercussions in the future. In this case these aircraft were delivered to C.A.U.S.A.—Compañia Aeronautica Uruguaya, S.A.—for operations across the River Plate.

Apparently the boats were ordered by C.A.U.S.A. and converted into sixty-seaters. The managing director of the company came over to this country, but, not unnaturally, found considerable difficulty over the present-day international requirements in such matters. The boats had been insured by a firm in Lloyd's, and the chairman of this firm decided thereupon to take the whole thing over, engaging the necessary crews and making the various arrangements. He himself, with the aviation co-director, flew over in the first of the boats—an effort which considerably impressed the Uruguayans.

There was an exciting (and possibly apocryhal) epilogue when, after the arrival of the first boat, the managing director, Col. Don Tydeo Larre Borges, who had never before handled a Sunderland, more or less immediately took a hull-full of blissfully confident passengers on a trial run between Buenos Aires and Montevideo. There were a few excitements on the run-up—during which the mooring cable parted under the load—but all was well. C.A.U.S.A. have previously been using Junkers 52 seaplanes on their services.

BREVITIES

When the first Dutch aircraft left Schiphol Airport on the Moscow-Amsterdam service a few days ago, it carried 30,000 Dutch bulbs as a gift for the city of Moscow.

* * *

The Interim Council of the P.I.C.A.O. has proposed that thirteen weather ships should be maintained in the North Atlantic. These will also be used for air traffic control and rescue work.

* * *

Chambers of Commerce and similar civic organizations in America are now permitted to intervene, in their own right, in cases before the Civil Aeronautics Board which involve new routes or other formal proceedings.

* * *

Trans-World Air Lines have appointed Capt. John T. Murphy as their Irish Traffic representative. Capt. Murphy served in the Eire army as Staff Officer to the Director of Supply and Transport Services during the war.

* * *

Peruvian International Airways has been given permission by the Peruvian Government to establish an airline between Lima and Montreal with stops at Panama, New Orleans and Washington or New York. The service may later be extended to other countries.

* * *

Agency and service agreements have been reached between Tata Air Lines and Trans-World Airways, to cover operations in India.

* * *

A new air service which will start operations in India in August this year, linking Calcutta, Bombay and New Delhi, has been formed by Mr. K. S. Balakrishnan. The company will be known as Bharat Airways, Ltd.

* * *

Mr. T. L. Hogan, Chief Airport Engineer to the Eire Department of Industry and Commerce, has left Shannon Airport for America in order to study the latest developments in the United States in the design and layout of airports.

* * *

Criticisms are being made locally of the fares now being charged by the East African Airways Corporation, which took over from the old Wilson Airways. For instance, while the landplane fare between Dar-es-Salaam and Mombasa was £6 10s, that by flying boat is £11.

* * *

Butler Airways of Australia has now been floated as a public company with a capital of £200,000. It operates internal services from Sydney, and its managing director is Mr. C. A. Butler, who made a record-breaking flight in a Comper Swift between London and Australia.

* * *

The first Constellation belonging to Panair do Brasil, S.A., to arrive in this country, landed at the London Airport recently. It was the first airliner of a foreign airline company to use the airport. Panair do Brasil are to employ four of these machines on a weekly service from Brazil to England via Dakar, Lisbon and Paris.

* * *

Luxury air cruises to Switzerland at a cost of £75 per head are to be run throughout the summer beginning on May 31st by Sir Henry Lunn, Ltd., the travel agents. Yorks will be used, and there will be two flights leaving London each week for Zurich. The cost of the cruise includes rail fare between Zurich and a selected destination, and fourteen days' hotel accommodation at first-class hotels chosen by the traveller.

* * *

Mr. G. A. Auguste and Mr. G. Ashton, who are employed at B.O.A.C.'s Bournemouth station, will this year have served jointly for 50 years in civil aviation. Mr. Auguste is Senior Traffic Officer at Poole, and Mr. Ashton is in charge of the Import Bonded Warehouse at Hurn.

Jet Propulsion for Civil Aircraft

PAPER BY
MAJOR F. B. HALFORD,
F.R.Ae.S., M.S.A.E.

Hypothetical Air Liner for High-speed, High-altitude Operation : Axial-flow Power Units : Performance and Costs

ON Wednesday, May 1st before an audience of technical and non-technical members and guests of the Royal Society of Arts, Major Frank Halford, designer of the D.H. Goblin and Ghost engines, read his paper on Jet Propulsion. He commenced by reviewing very briefly the history and working principles of jet power units and then turned his attention to pure jet propulsion for civil airliners.

Major Halford dealt simply and concisely with the advantages, requirements and problems associated with aircraft as a means of transportation under headings of speed, drag, inefficiency of airscrews at very high speeds, and the efficiency, almost limitless power and simplicity of jet units. His explanation, in simple terms, of compressibility and its kindred problems was excellent.

Aircraft and Engines—One Problem

In more detail, Major Halford dealt with the need for air-conditioning for high-altitude flying and then described the features of an imaginary airliner that could be built during the next ten years, the time depending upon the men and money devoted to such development. "Let us consider a machine of 190,000lb all-up weight," he said. "First of all it is quite impossible to split the aircraft and its power plant into two separate problems. If we are to achieve the optimum overall result the two problems must be regarded as one." In choosing four power units for the hypothetical aircraft he added, "If we adopt more than four it would entail more complication and maintenance than is necessary. If we adopt less than four (for long-range work) we should not be in a happy position in the event of one unit failing in the air. Four, therefore, appears to be the ideal number, providing the units can be installed without adding appreciable external drag, and we will place them in the wings as we shall need all the fuselage space for passengers, mail and other purposes."

TRANSATLANTIC TYPE

General Characteristics

Total weight	190,000 lb
Wing loading	58 lb/sq ft
Engine static thrust (nominal rating)	4 × 12,000 lb
Payload—non-stop } 15,000 lb New York-London }	50 passengers and luggage at 230 lb + 3,500 lb mail and/or freight
Cruising speed	615 m.p.h. at 40,000 ft (M=0.925)
Take-off run, still air, hottest day anticipated in New York (104 deg. F.)	2,000 yd to 50 ft

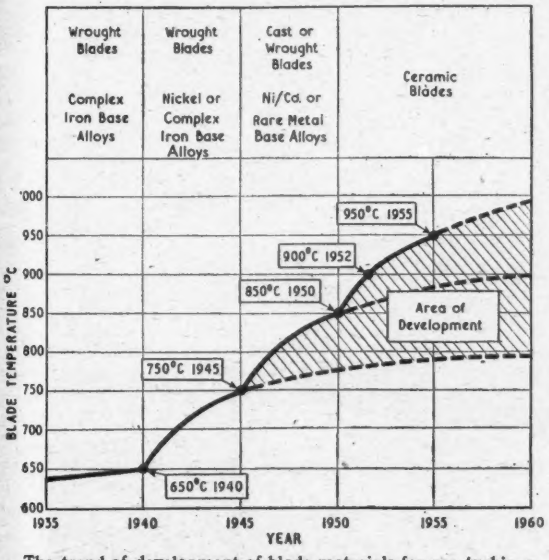
Journey Times and Costs
(Allowing for average westerly wind of 50 m.p.h.)

Depart London	6 p.m. G.M.T.	Elapsed time 7 hr 6 min
Arrive New York	8.06 p.m. E.S.T.	
Depart New York	12 midnight E.S.T.	Elapsed time 6 hr 14 min
Arrive London	11.14 a.m. G.M.T.	
Single fare		Approx. £60

With regard to the selection of the jet units he said, "Now at, say, 40,000ft, the aircraft in view needs a total thrust of 10,200lb to propel it at its selected cruising speed. This means that each of the four units must be designed to give a thrust, at 40,000ft of 2,550lb for the minimum possible fuel consumption. Bearing in mind what has been accomplished to date, and allowing for improvements which can reasonably be expected in the near future, I suggest that the following design target figures need not be considered unreasonably optimistic for a jet engine cruising, say, at 40,000ft at 600 m.p.h.

Expansion ratio	15 : 1
Compressor efficiency ..	85 per cent
Combustion chamber "drag" efficiency	95 per cent
Specific fuel consumption	0.88 lb/hr/lb thrust.

On the subject of the take-off possibilities of such a unit Major Halford said: "Here we come up against a design 'critical.' It has become common knowledge that one of the main difficulties which faced Air Commodore Whittle and pioneers of the gas turbine was the lack of suitable material for the turbine blades, which have not only to operate in gas temperatures of over 600 deg C, but which are, at the same time, subjected to centrifugal and bending stresses of a high order." (The progress made in turbine blade material is graphically illustrated, left.)



The trend of development of blade materials for gas turbines. The curve is based on the assumption of 300 hours' life at full duty with a blade stress of 11 tons/sq in.

Turbine Blade Temperatures

"For take-off purposes we do not mind if the specific fuel consumption increases; all we want is the highest thrust in order to reduce the take-off run to the minimum. In a given turbine this would depend on what temperature we dare to run the turbine blades, and for the turbine we have in mind I think a maximum blade temperature of 850 deg C—corresponding to a gas temperature of 1,000 deg C at entry to the turbine—should be obtainable by 1950. Perhaps one ought to add that there is an alternative to this continuous chase after higher temperature-resisting materials for turbine blades, namely to cool the blades internally with air or water. In practically all their jet units the Germans adopted air-cooled turbine blades, owing to their wartime shortage of suitable heat-resisting materials. The temperatures mentioned," said Major Halford, "would ensure a maximum take-off thrust from

JET PROPULSION FOR CIVIL AIRCRAFT

each of the four power units of 15,000 lb."

A schematic drawing of the imaginary jet unit was illustrated. The diameter was 5ft, the length 17ft, and the weight 6,000 lb. It was intended to run at 6,200 r.p.m. and to give a nominal static thrust of 12,000 lb. at 800 deg C before the turbine. A 14-stage axial-flow compressor was driven by a three-stage turbine, developing a maximum of 28,500 h.p.

Turning to the subject of the aircraft, Major Halford said: "The main object in view is to design a machine of the highest possible cruising speed, taking the fullest advantage of the jet units envisaged, but with due regard for the limitations imposed by compressibility problems. It is suggested that the designed cruising speed (M=0.925) should not be regarded as unduly optimistic. Aircraft designers may differ as to the best way of avoiding the onset of the compressibility problem; one might adhere to the standard plan form of the wings but use ultra-thin sections; another might prefer to sweep back the wings and remove the tail with the same end in view; while yet another might decide to suck away the boundary layer."

Transatlantic Costs

The general characteristics of the machine based on trans-Atlantic services were then illustrated in tabular form (page 473), and it was pointed out that each machine was deemed to make one return trip per 48 hours; this would average under seven hours flying per day. Tankage for 10,000 gallons of fuel would need to be provided, and each machine would cost between £300,000 and £500,000 depending upon the quantity produced. Of this cost each jet unit would account for at least £20,000. Also given in the table, previous page, are the journey times and costs for the same service, and fares were based on the assumption that to-day £90 is the proper figure to charge for trans-Atlantic cruising by air.

Major Halford then went on to discuss the use of the aircraft for Empire routes. He said: "The payload can be increased to 22,000 lb, which allows 72 passengers and luggage with an additional 5,400 lb of mail or freight for stages up to 2,200 miles. The total weight is reduced to 176,500 lb and the take-off run in still air with 120 deg. F. air temperature is about 1,950 yards to reach a height of 50ft above sea level assuming present-day gas inlet temperatures of 800 deg. C."

Some representative journey times and costs for this service were tabulated (see above). Concerning them the lecturer said: "The estimated Empire route fares quoted in the table are based on a direct operating cost of 9.5d per ton-mile of payload, and it is interesting that a directly comparable estimate of the direct operating costs for a machine of the DC4 type, operating over similar stage lengths, gives 15.2d per ton-mile with a cruising speed of 274 m.p.h., i.e., the direct operating cost of a slower machine is 60 per cent greater. I ought to make it clear, that in the calculations if direct operating costs, the price of petrol for the piston engine has been assumed as 2s per gallon, while the price of paraffin for the jet unit has been taken at 1s 4d per gallon. Even if both fuels were the same price per gallon (2s) the jet-propelled liners' operating cost would be 12d per ton-mile as against 15.2d per ton-mile for the DC4 type machine. It is submitted that the jet air liner of the future will be able to offer considerably higher speed than present transport and at appreciably lower cost. Furthermore, at speeds of the order of 600 m.p.h. the specific consumption of the simple jet engine works out at only 0.54 lb of fuel per thrust h.p./hr. which is as good as the performance of a piston engine and airscrew combination at about 300 m.p.h. and is considerably better than any engine-airscrew combination at 600 m.p.h."

EMPIRE TYPE

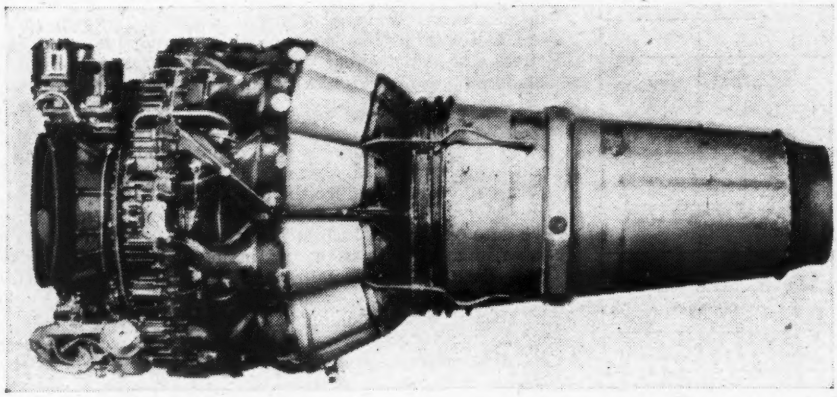
Route	Distance in Miles	Average Wind, m.p.h.	Number of Stops	Total Elapsed Time, hrs.	Flying Time, hrs.	Single Fare.
London to Sydney	11,600	25 T.W.	5	28.8	22.3 }	£155
Sydney to London ...	11,600	25 H.W.	5	30.3	23.8 }	
London to Cape Town ...	6,975	25 T.W.	3	17.7	13.8 }	£93
Cape Town to London ...	6,975	25 H.W.	3	18.6	14.7 }	
London to Buenos Aires ...	7,160	—	4	20.4	15.2	£96
Buenos Aires to London ...	7,160	—	4	20.4	15.2	£96

A Step Missed Out

In conclusion, Major Halford commented on the fact that when Air Commodore Whittle very rightly threw away the airscrew and developed the gas turbine unit as a pure jet machine he, in a manner of speaking, missed out a step. "Had he used the gas turbine to drive an airscrew, the aircraft designer would have been able to step up his aircraft performance to take full advantage of what would have been a reasonable forward stride in power plant development. Obviously for slow-speed flight, or for low altitude work, airscrews will remain in favour."

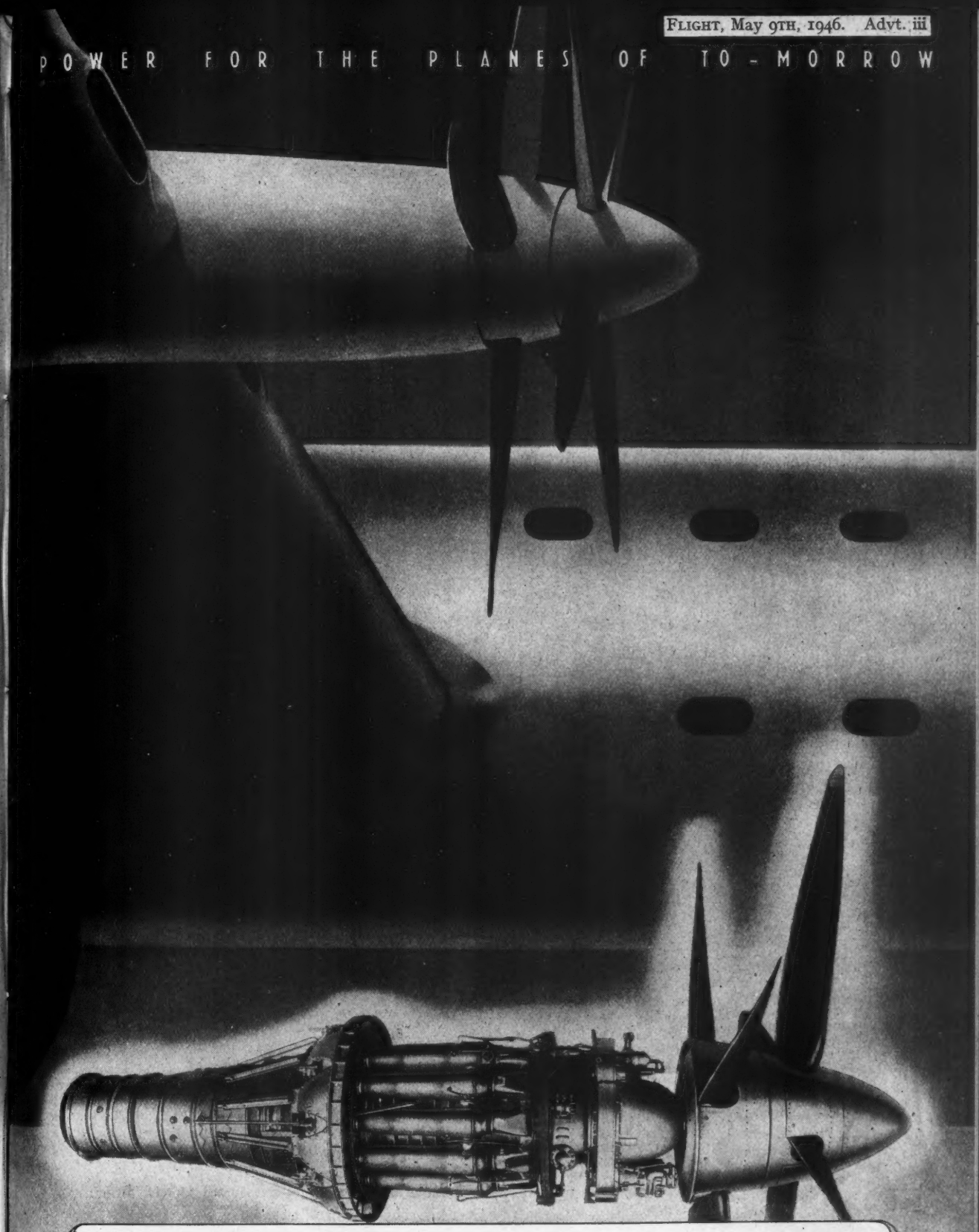
"There is a popular idea that increased speed means increased cost, but in air transport this is not necessarily true. Every year since the first flown aircraft was put on service, speeds have increased and operating costs per passenger mile have decreased, and I submit that the design study in this paper is no exception to the rule. Admittedly, it is true that head resistance or drag increases as the square of the speed, but only if the density of the air remains the same. At 40,000ft our hypothetical aircraft at 615 m.p.h. encounters no more drag than it will incur at 305 m.p.h. when flying at sea level. To take an even more striking example, a V2 rocket travelling at 3,500 m.p.h. at about 300,000ft experienced no more drag than it would if it travelled at about 4 m.p.h. at sea level. Therefore, to fly fast yet economically we must fly high, and the faster and higher we fly the greater the claims of pure jet propulsion.

(*The discussion which followed appears on page* 476.)



The Ghost II, latest de Havilland jet unit designed by Major Halford, gives a static sea-level thrust of 5,000 lb. The ten combustion chambers (the Goblin series has sixteen) are fed through forked ducts of unusual design.

POWER FOR THE PLANES OF TO-MORROW



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A. V. ROE & CO. LIMITED, MANCHESTER (BRANCH OF HAWKER SIDDELEY AIRCRAFT CO. LTD.)

Britain's Test Pilots

No. 8

CHARLES K. TURNER-HUGHES

"Flight" photograph.

KNOWN throughout the aircraft industry as "T-H," Turner-Hughes has had a very varied career and is, in addition to his ability as a test pilot, a past-master at aerobatics. His flying hourage exceeds 6,800 and his log books show 162 different types.

Taking a short-service commission in the R.A.F., he learnt to fly at No. 5 Flying Training School on Avro 504 Ks and Sopwith Snipes. The Snipe was the last aircraft to go into service with a rotary engine. On qualifying for his wings, he was posted to the famous No. 56 Squadron, which has such a wonderful record both in the 1914-18 and in the recent campaign. Here he flew Gloster Grebes and later Siskin IIIAs. This was his first introduction to the Siddeley Group aircraft, and the Siskin was the earliest all-metal fighter to go into service with the R.A.F.

His next move, in 1930, was to No. 24 (Communications) Squadron (which can be considered as the beginnings of Transport Command) where he flew such exciting types as Moths, IIIFs and Wapitis. When the late Ramsay Macdonald, then Prime Minister, was flown by No. 24 Squadron to visit Hindenburg in Berlin, he wore a seat-type parachute over a Sidcot suit and sat in the open cockpit of a Wapiti. Things are different for V.I.P.s to-day. Turner-Hughes did not pilot the Premier, but flew his personal assistant.

In 1931, when his commission came to an end, he came out of the Service and joined Caribbean Airways in Jamaica. This airline company had a Moth, a Fairchild on floats, and a Vickers H-boat. This latter was very like the Walrus, but had an American 400 h.p. Liberty engine which was a remnant left over from the 1914-18 war. After six months of this work he returned to England and joined the Cobham air circus. This travelling air display and joy-riding concern was, I suppose, the biggest of its kind in the world. Charles stayed with it for two seasons. His share of the show was aerobatic and low inverted flying on a Tiger Moth. For six shows a day, Sundays included, he was paid £25 per week. This was later increased to £30.

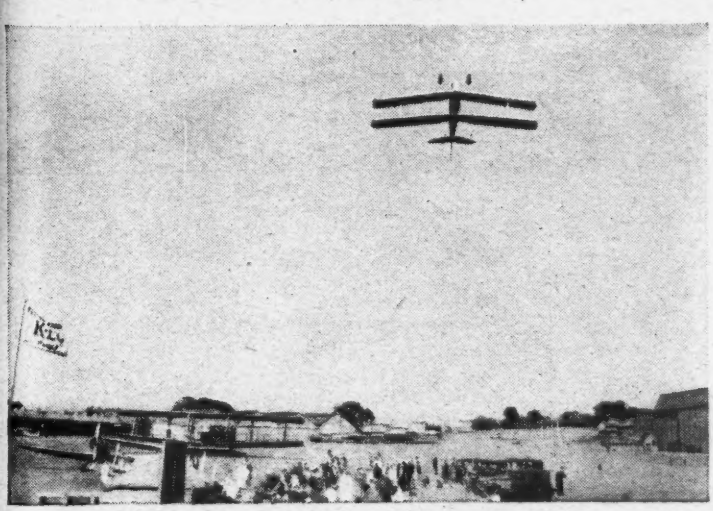
Having had a sufficiency of barnstorming, Turner-Hughes then turned to more serious flying, becoming No. 2 test pilot to Campbell-Orde at Armstrong Whitworths, and in 1936 became chief test pilot. This post he has held for ten years until he gave it up a fortnight ago. His first prototype was the A. W. Scimitar, a single-seat fighter, and all A. W. types from this, right up to the 52-G flying-wing glider, were his responsibility.

Deadstick Landing

The Ensign (span 123ft, weight 48,500 lb) is the biggest aircraft he had to handle, and this was also his first experience of flying a four-engined type. On its fourth test flight T.-H. had a sticky passage. He had intended to stay up some 2½ hr on some sound-proofing trials. At the end of one hour, however, first one engine stopped, to be followed quickly by the other three. This was at 7,000ft, and he had a load of technical men on board. Finding himself in the Oxford area and within gliding distance of Bicester airfield, he put down the wheels and made a four-dead-sticks landing without breaking anything. This was entirely against regulations because if by a slight misjudgment he had not got into Bicester a wheels-down crash landing would have wrecked the whole machine, whereas usually a belly landing does local damage only.

Eric Greenwood, who was then Turner-Hughes' second in command, and is now chief test pilot of Glosters, was flying with him at the time. The trouble had been caused by the aircraft running all four engines off one tank instead of two. Since the fuel cocks were some 20ft away from the pilot's seat it was impossible to check them.

He also had a "shaky do" on the original prototype Whitley. On the first flights there had been considerable trouble with the elevator becoming very stiff during turns, and a universal joint was fitted in the centre of the elevator spar. This was made of dural, and after a few flying hours it showed wear, and at speed caused most terrific elevator flutter; so much so that on this occasion, while doing level speeds, T.-H. found himself hitting the roof in the violent undulations. He told his observer to jump, but



FORTY TWO TIMES A WEEK: For two seasons Turner-Hughes did inverted flying for Cobham's air circus six times a day, seven days a week.

BRITAIN'S TEST PILOTS

for some reason he did not go, so T.-H. also stayed, and eventually brought the aircraft under control again. After landing it was found that many rivets had been loosened or torn out, the fairing between the body and wings broken, and all the ballast weights were loose. Even the safety cables underneath the bombs were broken. Despite its shaking, this Whitley was finally repaired and completed its trials at Martlesham. Turner-Hughes did the diving tests on this actual aircraft.

His closest go, however, was when testing a Lancaster II. While diving across an airfield a flock of plovers got up and one came right through the Perspex cockpit hood, hitting him in the face, breaking his nose and knocking him out. The Lanc. was then doing something in the region of 300 m.p.h., and he had no second pilot with him. The next thing Charles remembers was the flight engineer wiping the blood from his face with some very oily rags. Meanwhile the aircraft had flown itself for three-quarters of the airfield circuit and by then he was just able to see sufficiently through a haze of blood and oil to bring it in. After landing he promptly passed out again, and remembered no more until he was being stitched up in the surgery.

Now that he has left A. W.s, he intends only to do free lance test flying in addition to starting his own agriculture machinery supply and repair business in the Midlands. He has put in 20 years' good work, and his total "breakages" amount to one airscrew and one Siskin. J.Y.

Turner-Hughes in the cockpit of the A.W. flying wing glider (52-G.) on which he made the first flights.

JET PROPULSION FOR CIVIL AIRCRAFT

THE DISCUSSION

(Continued from page 474)

OFFERING thanks for the paper the Chairman, Air Comdre. Whittle, said that Maj. Halford had put into words what he had himself been thinking but not daring to say. He felt that there was some psychological resistance to high-speed flight but that we should be used to it in ten years' time. He was not quite so certain that we should want transport aircraft so large as Maj. Halford had suggested. He invited Sir Roy Fedden to open the discussion which he did with the question whether we could afford pressure cabins on what he called the motorbus type of air transport—and if not could we hope for pure jets that could be efficient at lower speeds such as 400 m.p.h.? Maj. Halford, however, felt that if the speed must be dropped by 150-200 m.p.h. in order to avoid the expense of pressure cabins then the turbine-propeller unit would be more economical.

Air Marshal Sir James M. Robb, A.O.C. in C., Fighter Command, asked for his comments, said that the Royal Air Force already had the Vampire (Goblin II) and the Meteor in service and the transition to jets had been an easy one—in fact these aircraft were more pleasant and quieter than anything they had had before. Now the call is for more thrust for better climb, for they really need the same speed vertically as they have horizontally.

Maj. Bulman's comment was that on Maj. Halford's reputation as a prophet we could place faith in his prediction. In the first great war he had prophesied the aluminium monobloc and it had come to pass; he had prophesied motor car serviceability from the aero engine and had himself achieved it in the Gipsy; against expert opinion he had forecast the double-crankshaft, and it had worked; he had boldly ventured in the single-sided impeller, and it was a success. His jet transport would surely be realized.

Mr. Geoffrey Smith's opinion was that a rather smaller and slower aircraft would need to be tried out before the ambitious type envisaged in the paper. Compressibility and other problems needed solution before large 615 m.p.h. civil types were possible. Evolution was a gradual process; he admired the lecturer's enterprise. He particularly sought an opinion about the prospects of the really small turbine for light aircraft, and Maj. Halford replied that he would rather not prophesy concerning this more difficult size until further experience had been gained.

Mr. R. G. Worcester asked for a yardstick for comparing powers, to settle, for instance, the problem whether the Nene, Python or Ghost is the world's most powerful turbine today, but Maj. Halford could offer no simple measure and explained that the overall picture of the aircraft, particularly the cost of its air ducting in regard to space, weight, and efficiency, must be taken into account.

Several speakers referred to the practical difficulties of engineering a satisfactory pressure cabin which, although not to be compared with the aerodynamic problems, might well retard the whole development. Sir James Robb asked what horsepower would be needed for the air pressurizing and conditioning of a fifty-passenger cabin and Mr. E. S. Moult (Chief Engineer of the D.H. Engine Company) said that preliminary estimates suggested between 200 and 300 horsepower.

Concluding the discussion Air Comdre. Whittle considered that Maj. Halford had found in the meeting a greater measure of agreement with his forecast than either he or Air Comdre. Whittle had expected. This view of the future had needed stating.

The Air Comdre. gave his own opinion about a modern yardstick for powers. Because airscrew efficiencies might be as low as 53 per cent at 600 m.p.h. it was fictitious to speak of shaft horsepower. He suggested a gas horsepower equivalent to the kinetic energy in the jet. As a final comment he thought that Maj. Halford could well have assumed 94 per cent for turbine efficiency ten years hence as 90 per cent has been achieved already.

Sir Geoffrey de Havilland proposed thanks to the Chairman whom he said everyone knew was the father of the jet.

FORTHCOMING EVENTS

May 12th.—Society of Model Aeronautical Engineers Extraordinary General Meeting at 11 a.m., Waldorf Hotel, Aldwych, London.

May 18th.—College of Automobiles and Aeronautical Engineering, Chelsea; Old Students' reunion dinner, Gt. Eastern Hotel.

May 24th.—Cambridge U.A.S. 21st Anniversary dinner, University Arms Hotel.

May 30th.—R.Ae.S. The 34th Wilbur Wright Lecture, by Mr. E. L. Relf (I.C.E, Gt.. George St.).

June 1st.—R.Ae.S. Reading and Dist Branch: Aeronautical Garden Party, Woodley.

June 15th.—Old Cranwellian Assoc. reunion, R.A.F. College

June 15th—No 150 Sqn R.A.F. Reunion dinner, Dorchester Hotel, 6.30 p.m.

June 22nd.—Air Pageant, Southampton Airport.

June 30th.—Northern Heights M.F.C. Gala day, Langley Airfield, Nr. Slough.

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CORRESPONDENCE

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

No. 170 SQUADRON
News of Photograph Wanted

I WONDER if any of your readers, ex-members of 170 Squadron, Bomber Command, could help me trace a photograph of the squadron which was taken at Dunholme Lodge R.A.F. Station, near Lincoln, in November, 1944?

It was the only one ever taken and, being unofficial, there is no record of it at the Air Ministry.

British Red Cross. (Miss) FRANCES E. THOMPSON, M.S.R.

THE MASTER CONTROL
Official Confirmation

SORRY, "Indicator," but Mr. Hall is right. The safety stops on the two undercarriage levers are interconnected by Bowden cable, so that the undercarriage can be raised from either cockpit.

As if Miles Aircraft, Ltd., would overlook such a point!

D. L. BROWN,
(Miles Aircraft, Ltd.).

[Several other letters have been received in which the writers make the same point. On handing "Indicator" his humble pie for solitary consumption, he said, "Evidently I did an insufficient amount of back-seat driving."—ED.]

FLIGHT OF BIRDS
A "Brains Trust" Theory Challenged

IN a recent B.B.C. Brains Trust session the question arose why certain breeds of birds when flying, especially in migration, formate in squadron-vee, and the matter was disposed of by Dr. Julian Huxley. He completely tabooed the general notion that the birds always had a rightful and accepted leader and held that the reason is entirely aerodynamic, i.e., that the birds get in close together and so reduce overall drag when they are flying long distances and desire high speed.

With all due deference to such an authority as Dr. Julian Huxley, I find this theory a little hard to swallow, and perhaps some others can throw light on the matter.

STANLEY BRADSHAW.

HEIGHT CONSCIOUSNESS
Experience of Helicopter Pilots

MAJOR "JIMMY" CORDES, that extremely experienced test pilot, tells me that when helicoptering above 2,000ft he is very conscious of height, and wonders if the direct downward view is responsible. Lying in the bomb aimer's glass-house, in various bombers at various heights, I have neither had the sense of height, nor heard of anyone who had.

Sqn. Ldr. Arkell, who was the chief instructor at the R.A.F. helicopter school, used to get this height sensation at 5,000ft when helicoptering on radar work. He supports the downward-view theory, and says that bomb aimers may be spared because they are prone. May forward speed enter the argument? And have we a cast-iron explanation for the lack of the height sensation in fixed-wing flying? J. D. S. ALAN.

REWARD FOR SERVICE
And the Song They Sang at Halton

THE letter by "Wing Co." in your issue of April 18th, has its points. May I please be allowed to add a few words concerning ex-apps: to whom the officer's mess proved no cynosure or who for various reasons (often the realization of being able to pull their weight—and then some!—as W./O.s or S.N.C.O.s), were not commissioned under war emergency.

Having (or electing) to seek opportunity, peace and settlement in civil life for which they have been fighting, and incidentally serving since school days, presents difficulties no less than for ex-Wing Co. Apart from the question of E.V.T., there is a general bar on ex-regulars benefiting under the Further Education and Training Scheme. This, in spite of the fact that skilled Service trade seldom qualifies in civil application; witness, necessity for G.E.'s licences.

For all such (completion of 12 years plus), there is not the support of "£90 p.a. or so" although, let it be noted, that for "Wing Co.," each year of service in the ranks becomes, by reason of being commissioned, valuable for half-rate officer's service benefit.

This all reminds me of a song we loved to sing occasionally at Halton—"Let's have a —— good cry," but such sentiments are sometimes justified. EX-W/O. "SAM."

"KEEPING THEM RUNNING"
The Author Replies to a Critic

THE communication from Mr. R. E. T. Hack (*Flight*, April 18th) is appreciated by the author of the article in question and his letter necessarily calls for a reply. By virtue of Mr. Hack's apparent knowledge he has kindly amplified certain statements that were quoted, but which inevitably suffered brevity. However, it would appear that he has failed to appreciate that "Keeping Them Running" was written as a generalization of servicing and maintenance on a variety of gas turbines and not confined to any particular design as his letter seems to imply.

For those who service and maintain aircraft, it is a normal assumption that the determination of any faulty component has first been established, either by mental reasoning or investigation, before it is replaced, and such qualification may therefore be considered superfluous. The reference to r.p.m. "hunting" is presumed to be a supplementation, though in taking a cross-sectional analysis of fuel-system faults from a number of types, a more common cause for erratic operation is that referred to in the last sentence of his relevant paragraph, particularly where the fuel system incorporates a composite unit wherein the throttle valve and a.s.g. is fitted, the latter partly in lieu of an a.c.u.

It is difficult to accept the statement that "practically every defect" falls under the heading of "power losses"; there are many defects which may arise, though seldom do, that have no direct bearing at all on power output, and while to the maintenance expert the typical list of possible power loss causes may appear both elementary and obvious, such is not quite the case to the uninitiated. The phrase "aerodynamic breakdown" was not intended to be confused with mechanical breakdown; the implication was to differentiate between the two.

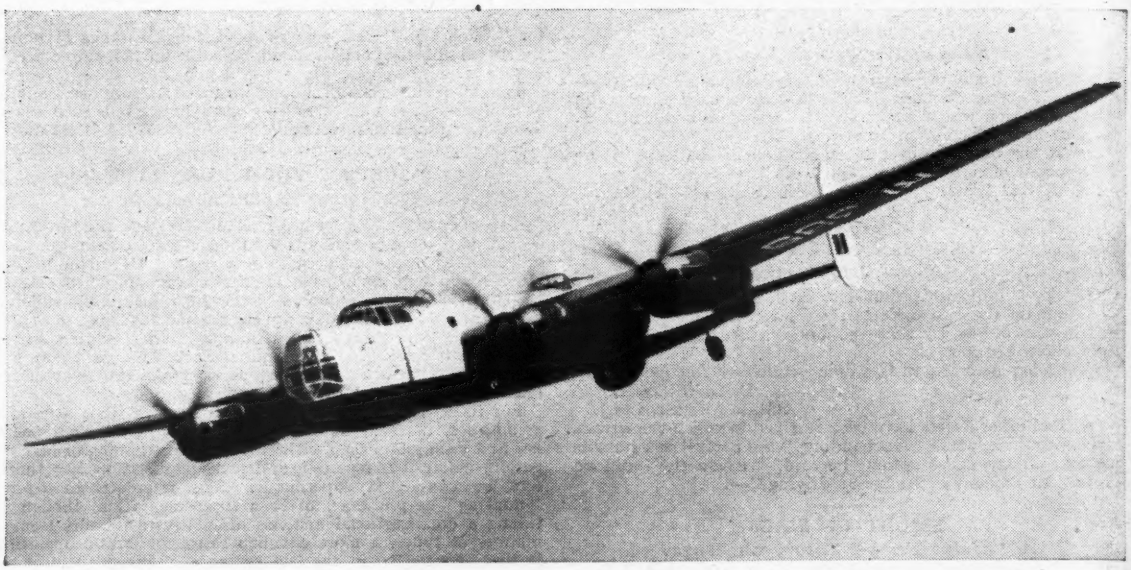
It is further observed that Mr. Hack is also in agreement with the author regarding the inverse efficiency of the compressor with respect to increased impellor/compressor casing clearances, and since it has already been inferred that rectification of troubles akin to this component necessitates a complete strip, Mr. Hack's remarks are further confirmation.

It may certainly be said that propelling nozzle distortions on British gas turbines is a very rare occurrence, though all gas turbine designers have not enjoyed this success. For instance, certain German-built gas turbines, after extensive running for the type, have shown a marked deterioration of the propelling nozzle assembly, from which inferiority pressure losses emanate and directly influence the propulsive efficiency. On the other hand the reference to detrimental effects from jet pipe gas leaks is sound and good advice. Regarding bearing troubles, perhaps "faulty" would have been a more suitable and comprehensive adjective and would have included such remote contingencies as partial seizures.

One of the principal limitations to additional power from a given size unit is the maximum permissible temperature of the turbine moving blades. Thus any negative heat transfer that takes place from these blades will assist in permitting the maximum operating temperature to be increased, potentially raising the power output—provided, of course, there is no undue sacrifice in the turbine efficiency or overall performance of the engine. This is one of the primary reasons why some designers have advocated and used hollow static and moving turbine blades. The temperature of such blades is normally influenced by cooling air being ducted from the stator ring inner flange assembly and the periphery of the turbine disc to the outer extremities of the fixed and moving blades, finally exhausting into the main gas stream, heat transfer being effected mainly by convection. Experience has shown that if and when such turbine cooling systems fail, the jet pipe temperature will respond to the occasion. The rear bearing cooling air is an entirely separate issue.

R. M. CRACKNELL (Sqn. Ldr.).

SERVICE AVIATION



STANDARD HEAVYWEIGHT : A striking photograph of the Avro Lincoln, which is now in squadron service. Its efficiency, both in attack and defence, is greatly increased by the use of radar.

Royal Air Force and Naval Air Arm News and Announcements

Cranwell to Reopen

THE Air Ministry has announced that competitive tests for the first post-war course at the R.A.F. College at Cranwell for permanent commissions will take place in October next. No written examinations will be held, but candidates must have School Certificate or its equivalent, with three credits and at least a pass in mathematics.

Selection of candidates will be made by flying aptitude tests, selection tests, and an interview before a joint Civil Service Commission and R.A.F. Selection Board. Prospective cadets must be unmarried British subjects between the ages of 17½ and 19 on July 1st, 1946.

If successful, candidates will be enlisted and paid as airmen, receiving free residence and training. After completing the course, cadets will receive permanent commissions in the General Duties Branch of the R.A.F.

In addition to normal flying and navigational training, cadets will receive educational and general service training to prepare them for their duties as officers. On graduation, cadets will have reached the standard of the second year's work for a University pass degree, and will be qualified as pilots and in navigation.

Application forms and full details of the course may be obtained from the Secretary, Civil Service Commission, 6, Burlington Gardens, London, W.1. Application forms should be returned by May 31st. A fee of £2 is required for admission to the flying aptitude tests and a further sum of £3 for those who qualify for the final selection tests and interview.

These arrangements for the first post-war entry to Cranwell are of a provisional nature, and general peacetime conditions of admission and residence will be announced as soon as possible.

New S.E.A.C. Appointment

AIR MARSHAL SIR GEORGE C. PIRIE has been appointed Air Commander-in-Chief, H.Q., Air Command, South-East Asia, in succession to Air Chief Marshal Sir Keith Park, with effect from April 30th.

R.A.F. Training in Rhodesia

PILOTING his own Mitchell, Air Marshal Sir Roderic Hill, Air Member for Training, left for Rhodesia on May 1st to discuss with the Southern Rhodesian Government the question of continuing the wartime aircrew training scheme, under which 8,500 R.A.F. pupils were trained.

Sir Roderic will be joined in the discussions by a financial representative of the Air Ministry and Air Vice-Marshal J. Whitworth Jones, Director-General of Organization at the Air Ministry, representing Air Marshal Sir Leslie Hollinghurst (Air Member for Supply and Organization).

R.A.F. Reserve Command

THE first task of the new Reserve Command, the formation of which was announced in Parliament by the Under-Secretary of State for Air on May 1st, will be to make arrangements for both air training and ground training of personnel. When this has been done public announcements will be made inviting officers and men released from the R.A.F. to join the Voluntary Reserve and Auxiliary Units.

In addition to looking after the R.A.F.V.R. and A.A.F., the new Command will be responsible for the A.T.C., and, in co-operation with the University authorities, a number of University Air Squadrons will be re-formed. During the preliminary organization the headquarters of the Command will be at the Air Ministry, but later it will move to White Waltham airfield, near Maidenhead.

A Deputy Directorate of Auxiliary and Reserve Forces will be established, and the Directorate-General of the A.T.C. will cease to function. Consequent upon this arrangement the post of Commandant of the A.T.C. will also lapse and his responsibilities assumed by the A.O.C.-in-C. Reserve Command.

The new Command will comprise six regional groups, and these, in so far as the A.T.C. is concerned, will replace the present eleven areas. Arrangements for Northern Ireland are still under consideration.

The six regional groups, with their ultimate H.Q. locations will be:—

No. 61 (*Eastern Reserve*): R.A.F. Station, Kenley, Surrey.
No. 62 (*Southern Reserve*): R.A.F. Station, Middle Wallop, Hants.
No. 63 (*Western and Welsh Reserve*): R.A.F. Station, Hawarden, Chester.
No. 64 (*Northern Reserve*): R.A.F. Station, Rufforth, Yorkshire.
No. 65 (*London Reserve*): H.Q., Transport Command, Bushey Park, Middlesex.
No. 66 (*Scottish Reserve*): R.A.F. Station, Turnhouse, nr. Edinburgh.

After an aeroplane has taken to the air, a starter motor is just so much dead weight. The ROTAX combined starter motor and feathering pump motor is one example of how a live research organisation can not only reduce weight while improving performance, but can also achieve the work of two components for the weight of one.

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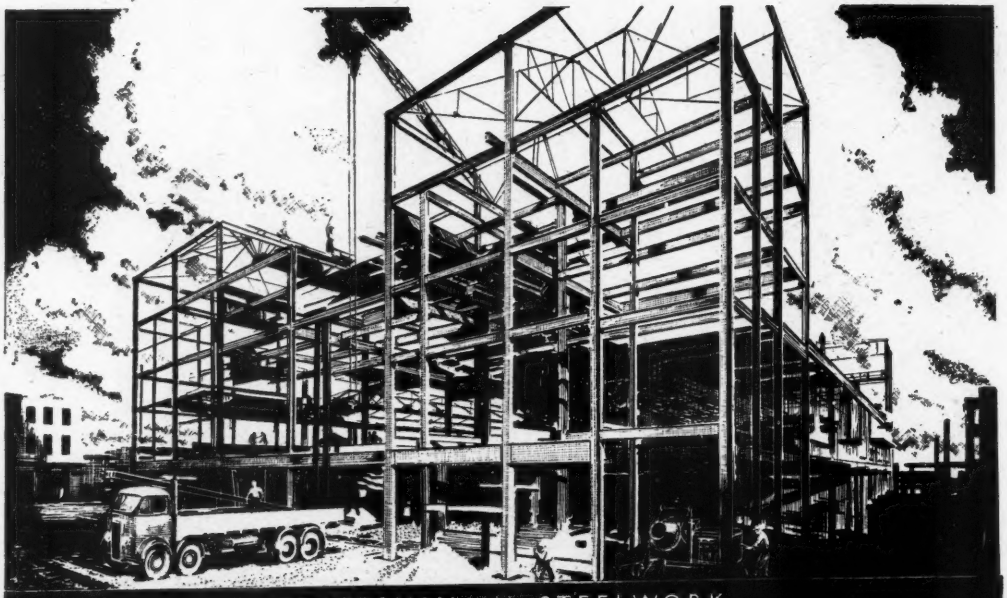

CRAFTSMEN IN STEELWORK

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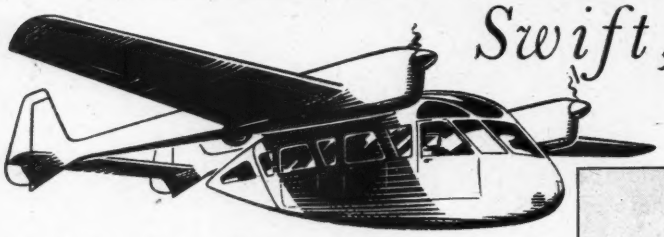

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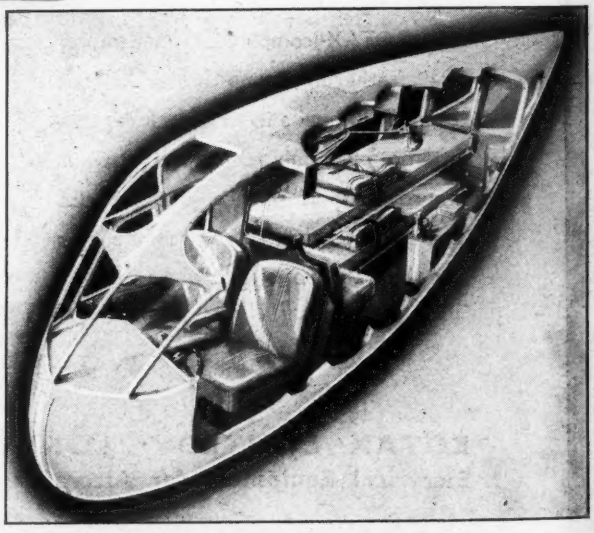

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SERVICE AVIATION

Roll of Honour

Casualty Communique, No. 577.

THE Air Ministry regrets to announce the following casualties on various dates. The next-of-kin have been informed. Casualties "in action" are due to flying operations against the enemy; "on active service" includes ground casualties due to enemy action, non-operational flying casualties, fatal accidents and natural deaths.

Of the names in this list 248 are second entries giving later information of casualties published in earlier lists.

Royal Air Force

KILLED IN ACTION.—Flt. Sgt. A. F. Calder; Flt. Sgt. W. T. P. Davies; Flt. Sgt. R. M. Herdman; F/O. B. Hobart; Flt. Sgt. D. McLeman; Flt. Sgt. R. Napier; Sgt. A. Smith; Flt. Sgt. D. H. Wild.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. R. B. Bright; Sgt. D. C. N. Burton; Flt. Lt. J. C. Horlock; W/O. J. F. Kelman; Act. Flt. Lt. J. R. Muir, D.F.C.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—W/O. R. W. F. Bodley; F/O. P. J. Abbott; W/O. W. H. S. Ansell; Sgt. M. Austin; F/O. F. P. Ball; Sgt. J. Bassett; Sgt. H. H. Bawden; Sgt. A. J. Bishop; Act. Flt. Lt. I. H. Bruce; P/O. J. C. Brunning; Flt. Sgt. J. D. Clarke; Sgt. V. N. Clayton; Flt. Sgt. J. A. Clements; Flt. Sgt. G. H. Cockburn; F/O. S. Cooke; F/O. J. S. B. Corry; F/O. J. G. Cossins; Sgt. G. Coyle; Sgt. A. W. Dawson; Sgt. P. Donnelly; Sgt. H. Dunn; P/O. D. P. Feeny; Sgt. J. R. Fuller; Flt. Sgt. J. Gardner; Sgt. J. D. Garland; Sgt. R. Garrad; Sgt. R. C. Gilbert; Sgt. A. D. Griffin; W/O. F. W. Griffiths; Sgt. M. R. F. Harris; Sgt. T. Hawthorn; F/O. D. C. Heather; Sgt. J. Houghton; Sgt. J. E. Judd; Flt. Sgt. A. H. Kerfoot; Sgt. J. E. Knott; Flt. Sgt. R. C. E. Lammas; Sgt. N. Lawrence; Sgt. A. E. Lukeman; Sgt. M. Lyttle; Flt. Sgt. W. McDermott; Sgt. D. McDonnell; Sgt. R. W. McGrain; W/O. P. McKee; W/O. W. W. McKeown; W/O. J. McKinnon; Sgt. N. McNeil; Flt. Sgt. G. E. Maidment; Flt. Sgt. D. G. Marchant; P/O. G. O. Maugham, D.F.M.; Sgt. W. T. Mercy; Sgt. G. Miller; Sgt. T. Moreland; Flt. Sgt. A. B. Nicklin; Flt. Sgt. A. Palmer; Flt. Sgt. W. N. Paterson; Flt. Lt. W. G. Payne; F/O. A. J. Platt; Sgt. F. G. Ralph; Flt. Sgt. D. S. Richards; Sgt. W. L. Sandilands; W/O. H. D. Scott; Flt. Sgt. E. J. Sharp; Sgt. D. C. R. M. Shearer; Flt. Sgt. K. J. Spackman; Flt. Lt. A. W. Thomas; Sgt. A. J. Tippin; Sgt. D. R. G. Watkinson; Flt. Sgt. J. Watt; Flt. Lt. G. K. Whitfen; Sgt. F. G. Whittaker; Sgt. C. Wilkinson; Flt. Sgt. D. H. Williams; Sgt. W. J. Wilson; Flt. Sgt. L. A. Windress; F/O. C. Worrall; Sgt. W. R. Young; F/O. W. Young.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Sgt. D. G. M. Brettell; Act. Sqn. Ldr. A. L. Carter, D.F.C.; Act. Flt. Lt. W. T. Cox; F/O. W. Dalgarno; Act. Wing Cdr. H. W. Eliot, D.S.O., D.F.C.; Sgt. W. H. Harper; Act. Flt. Lt. O. S. Milne; Flt. Sgt. B. Nundy; Act. Squ. Ldr. R. A. M. Palmer, D.F.C.; Sgt. A. S. Wheeler.

MISSING.—Flt. Lt. B. Bridge; Flt. Sgt. A. O. Chapman; Flt. Sgt. D. Gosling; Act. Sqn. Ldr. R. P. B. Grotrian; Flt. Sgt. R. Henderson; Flt. Sgt. D. A. Isley; P/O. R. R. Matthews; Sgt. J. H. Peckham.

KILLED ON ACTIVE SERVICE.—Flt. Lt. C. Batten, D.F.C.; W/O. R. H. Bolland; Sgt. R. W. Ellis; F/O. T. Glaser; Flt. Sgt. G. J. Patching.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Flt. Sgt. G. H. Butler.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—W/O. K. Midgley; Sgt. D. L. Reid.

DIED ON ACTIVE SERVICE.—L.A/C. J. H. A'Hern; A/C.1 P. G. Baguley; Flt. Lt. G. T. Balfour-Kinnear; Cpl. P. C. Beesley; Flt. Lt. G. R. Brown, D.F.C.; A/C.1 F. Brownhill; L.A/C. J. Bryan; Sgt. O. A. Burrlinck; L.A/C. J. Cohen; L.A/C. T. H. Cooper; L.A/C. G. J. Cottell; L.A/C. A. L. Crouch; L.A/C. J. Curd; F/O. H. G. Eadon; F/O. A. Edwards; Act. Sgt. M. J. Elias; Flt. Lt. H. R. Evans; Cpl. J. W. Flinn; Cpl. T. N. Gabb; Cpl. W. Gibson; F/O. H. B. Gray; Act. Flt. Lt. L. P. Hardy; Cpl. D. C. Hodgkinson; L.A/C. R. C. Jackson; A/C.1 W. C. Jones; Cpl. J. Kelley; L.A/C. G. B. Kent; A/C.2 R. Lemaitre; L.A/C. E. B. Lester; Cpl. N. A. Lonnen; Flt. Sgt. H. E. Lowe; L.A/C. J. McSweeney; Cpl. B. H. Martin; L.A/C. M. E. Maurice; Cpl. G. S. Millard; A/C.1 H. R. Morling; A/C.2 P. W. Morris; A/C.2 J. Owen; L.A/C. K. G. Pearce; L.A/C. W. H. Perowne; Act. Cpl. B. Pleavin; A/C.2 C. J. Pont; L.A/C. J. C. Preece; L.A/C. F. B. Ridgment; A/C.1 J. A. Ross; A/C.1 D. A. Sargent; A/C.1 G. H. Saltmarsh; L.A/C. J. E. Scott; Flt. Sgt. R. Scott; A/C.1 T. Sharrock; L.A/C. G. P. Shaw; Flt. Sgt. J. F. Sims; Cpl. D. B. Smith; Cpl. G. Smith; L.A/C. H. F. Smith; L.A/C. J. C. Stevens; A/C.1 H. S. Sticklee; Sgt. R. S. Thompson; Cpl. A. H. Trotter; A/C.1 W. H. Twidale; L.A/C. P. H. Underdown; Cpl. R. A. Webber; Flt. Sgt. W. G. Wilson; L.A/C. H. Wright; L.A/C. J. F. O. Yateman.

Women's Auxiliary Air Force

DIED ON ACTIVE SERVICE.—Cpl. L. Anson; A/CW.2 A. W. Auckland; A/CW.1 M. Bone; L.A/CW. B. Freestone.

Royal Australian Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—W/O. R. M. Bairnsfather; Flt. Sgt. W. D. Callaghan; Flt. Sgt. A. E. London; Flt. Sgt. A. T. J. Lovett; Flt. Sgt. J. A. Nelson; Flt. Sgt. D. C. Palmer; F/O. R. W. G. Stark; W/O. C. S. Swan; F/O. J. S. Walker; Act. Flt. Lt. B. M. Williams.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Act. F/O. P. N. Birt.

WOUNDED OR INJURED ON ACTIVE SERVICE.—F/O. N. P. Gilmour, D.F.C.

DIED ON ACTIVE SERVICE.—W/O. R. S. Hornabrook.

Royal Canadian Air Force

MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—P/O. E. F. Carlisle.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. C. N. Aune; Flt. Sgt. D. K. Clark; Flt Sgt. H. A. Dunphy; Sgt. A. L. Evens; Flt. Sgt. W. A. Gray; F/O. F. R. F. Skelly; Flt. Sgt. E. L. Stevens; F/O. D. J. Washburn; F/O. W. Webb.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—P/O. K. H. Austin; F/O. W. Baker; F/ /O. J. R. Beasley; F/O. G. C. Bellamy; P/O. F. E. Bentley; F/O. D. C. Bermingham; P/O. E. H. Bishop; F/O. S. B. S. Bishop; P/O. R. R. Boyce; P/O. C. R. Bradley; F/O. P. P. Brosko; W/O. D. L. Brouse; F/O. E. D. Brown; F/O. C. M. Buell; Flt. Lt. T. A. Bugg; P/O. V. C. Bullock; P/O. P. H. Burne; Flt. Sgt. N. A. Butler; Flt. Lt. E. C. Carpenter; W/O. J. Carswell; P/O. E. S. Cary; F/O. K. L. Chapman; F/O. K. C. Christian; F/O. C. J. Clarke; F/O. H. T. Conlin; F/O. W. N. Cosman, D.F.C.; Flt. Lt. S. H. R. Cotterill, D.F.C.; P/O. F. Coulson; F/O. O J Cox; Sgt. A. J Cybulskie; P/O. R. J. Delmage; F/O. W. L. Dennis; F/O. A. E. B. Denovan; P/O. J. A. T. Dick; F/O. A. Q. Downward; P/O. J. D. Duffin; F/O. A. L. Evans; Flt. Lt. C. G. Finlayson, D.F.C.; F/O. W. J. K. Fisher; Flt. Sgt. A. M. Fostey; P/O. W. F. Fraser; P/O. R. A. French; W/O. J. E. Gallop; P/O. L. P. Galvin; Sgt. T. M. Galvon; Flt. Sgt. L. A. J. Gauthier; Flt. Sgt. L. G. Griffith; P/O. G. S. Guthrie; Flt. Sgt. D. L. Hann; P/O. E. M. Hansen; P/O. D. L. S. Henderson; F/O. W. R. Heuchert; P/O. J. E. Howell; F/O. G. A. Humberstone; Flt. Sgt. J. R. Hunter; Flt. Sgt. L. M. Inman; F/O. D. G. H. Ireland; F/O. R. A. Ireland; Flt. Sgt. T. A. Johnston; F/O. J. A. Kancharik; Flt. Lt. F. A. J. Kemper; P/O. J. Kenny; F/O. T. Kowalchuk; W/O. M. A. Krewenchuk; P/O. D. H. Lavalley; P/O. L. C. Levasseur; P/O. W. L. Long; P/O. J. H. A. McCaffrey, D.F.C.; P/O. R. J. McCallum; P/O. R. McCloy; P/O. A. R. McDonald; F/O. L. A. MacDonald; F/O. H. J. McEachern; F/O. M. E. R. MacFarlane; F/O. E. W. MacIntosh; F/O. H. B. McIntyre; Flt. Sgt. J. G. MacKay; F/O. G. J. McKenzie; Sgt. A. R. McWhinney; P/O. D. H. Manson; F/O. M. J. Martin; P/O. C. G. Merritt; F/O. T. K. Montgomery; Sgt. A. H. Morrison; Flt. Lt. G. Nathan; P/O. J. W. R. Noonan; Flt. Sgt. D. C. Odell; F/O. E. W. Page; Wing Cdr. C. W. Palmer, D.F.C.; Flt. Sgt. I. F. Penny; P/O. S. L. Peters; F/O. R. W. Pettigrew; F/O. T. B. Phelan; P/O. V. E. Prouse; Flt. Lt. P. T. Reid; Act. Flt. Lt. A. W. Reif; P/O. A. G. Roski; P/O. M. Schwartz; W/O. R. W. R Shaw; F/O. N. F. Smith; F/O. W. Y. J. Soper; F/O. D. E. Stephens; P/O. M. Stern; F/O. M. Strosberg; F/O. G. S. Taylor; F/O. J. W. Thompson; P/O. V. A. Unruh; P/O F. S. Watson; Flt. Sgt. J. H. Williams; W/O. J. H. Wilson; F/O. K. C. Wing; F/O. F. Wittmack; P/O. E. D. Woods.

PREVOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—P/O. N. E. P. Douglas; F/O. T. N. McNulty; F/O. J. K. Reid.

Royal New Zealand Air Force

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Act. Sqn. Ldr. Umbers, D.F.C.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Act. F/O. G. A. Green; Flt. Sgt. L. C. Hickford; F/O. B. J Hosie; P/O. E. Howell; P/O. B. C. Jeffares; Flt. Lt. H. J. Meharry; W/O. G. J. Roney; P/O. G. W. Rowberry; P/O I. Sampson; F/O. J. G. Thomson.

South African Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Lt. C. A. Duran; W/O. J. J. B. Erasmus; Lt. A. J. Hastings; Lt B. T. Loxton; Maj. I. J M. Odendall; W/O J. A. C. Steel; Lt. T. T. Watson.

KILLED ON ACTIVE SERVICE.—Lt. J. H. Breytenbach; W/O. L. Keil; Lt. H. J. Stevens.

Casualty Communique No. 578.

Of the names in list 252 are second entries giving later information of casualties published in earlier lists.

Royal Air Force

KILLED IN ACTION.—L.A/C. F. J. Bryant; Flt. Sgt. N. W. M. MacKenzie; Flt. Lt J. G. Moulder; F/O. C. J. Sach.

MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—L.A/C. C. D Davies.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Flt. Lt. J. H. Brown, D.F.C.; Sgt. J. P. O. New; F/O G. S. Richardson; Flt. Sgt. J. McC. Scott; Flt. Lt. D. R. Wallace.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. J. D. Archer; F/O. L. N. Arkless; Sgt. J. A. M. Asquith; Sgt. J. W. Barnden; Flt. Lt. W. G. E. Becker; Flt. Sgt. B. D. Beddison; Sgt. J. Bell; Sgt. R. L. Bell; F/O. G. Beresford; Flt. Sgt. A. Bevin; Sgt. R. Birkby; Act. F/O. J. N. Bischoff; Sgt.

A PLACE IN HISTORY: The Gloster E.28/39, first British jet aircraft to fly, is here shown arriving at the Science Museum, South Kensington, where it will be kept on permanent exhibition.

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PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Sgt. H. Brooke; Sgt. H. H. Dunkerley; Sgt. L. Kilvington; Flt. Sgt. S. Richardson.

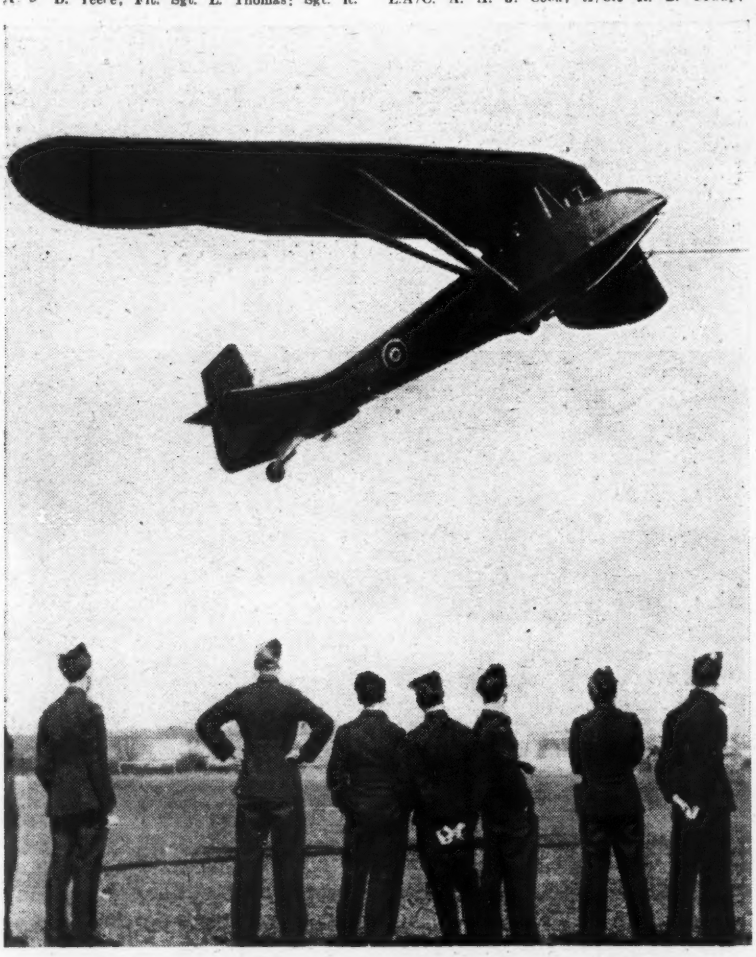
MISSING.—W/O. R. Broughton; F/O. J. C. Burns, D.F.M.; F/O. L. S. Drew; Flt. Sgt. R. Eglen; W/O. G. H. Fenney; F/O. A. G. Flippance; Sgt. L. P. Green; Sgt. W. J. Kennedy; Sgt. A. L. Knight; P/O. J. O. Laverack; Sgt. R. T. Martin; Flt. Sgt. J. A. Reardon; Flt. Sgt. N. R. Robbins; F/O. J. R. Skinner; Sgt. R. G. Steel; Act. Flt. Lt. G. Taylor; W/O. J. E. Topple; W/O. W. H. C. Ward; W/O. P. Webb; Flt. Lt. J. P. Whymark, D.S.O., D.F.C.; W/O. A. T. Worthington.

KILLED ON ACTIVE SERVICE.—Flt. Lt. D. G. Baker; F/O. T. Bell; F/O. J. Davey; Flt. Lt. J. C. Fearon; F/O. I. Lamont; F/O. B. J. McOwan, D.F.M.; F/O. R. E. Mellor; W/O. H. Steadman; F/O. F. Tomlinson; F/O. K. White; Sgt. O. O. Williams.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. M. N. Jones; W/O. A. W. Martin; Flt. Sgt. B. H. Potter; P/O. D. F. Prior.

WOUNDED OR INJURED ON ACTIVE SERVICE.—L.A/C. H. Thorpe.

DIED ON ACTIVE SERVICE.—Sgt. H. Ambrose; L.A/C. R. J. Anstey; A/C.1 S. T. Bartlett; A/C.2 T. C. Blake; A/C.2 L. F. Bougourd; A/C.2 T. S. Bridle; A/C.1 M. C. Brown; Cpl. A. Burnham; A/C.1 R. T. Bussey; A/C.2 A. W. Byerley; Sgt. A. C. Carter; A/C.1 N. W. J. Carter; P/O. A. G. F. Cheesewright; A/C.2 R. A. Clements; L.A/C. A. A. J. Cock; A/C.1 R. B. Cowap; L.A/C. R. Cowley; A/C.1 H. H. Crittenden; L.A/C. J. V. Crook; Cpl. H. R. Cuttell; A/C.2 R. W. Davey; A/C.2 V. W. Denton; A/C.1 A. Dickie; Flt. Lt. A. K. Duncan, D.F.C.; Act. Wing Cdr. J. L. Fowke; A/C.1 N. F. Garrard; Sgt. R. T. Goodman; Flt. Lt. R. Gordon; A/C.1 H. C. Goulburn; L.A/C. K. C. Gould; A/C.1 R. Greenwood; L.A/C. W. C. Harris; A/C.1 K. Haw; A/C.1 W. Hazel; Act. Flt. Sgt. F. S. Heatley; L.A/C. K. R. Lamb; Sgt. E. L. Le Feuvre; A/C.2 W. Lilly; L.A/C. H. Littlewood; A/C.1 J. McCormack; A/C.1 R. J. McGowan; L.A/C. G. E. Murray; L.A/C. E. J. Nicholls; L.A/C. W. J. Ott; A/C.1 F. Pafford; Sgt. D. A. Poland; Act. Sqn. Ldr. E. G. Pople; Cpl. A. E. Prescott; L.A/C. C. W. R. Redstone; L.A/C. J. M. Regan; A/C.2 R. V. Saul; L.A/C. R. N. Shaw; Cpl. R. F Shaw; Cpl. J. L. Stafford; L.A/C. J. C. Stephens; Flt. Lt. D. A. Stickland; A/C.1 J. G. Stiven; Cpl. E. Sutcliffe; A/C.1 P. Taylor; L.A/C. J. C. Warrender; L.A/C. W. D. Williams.



ALL OUT: A Falcon III two-seat training glider beginning a "high hop" at No. 143 (Croydon) A.T.C. gliding school. At the controls is a pupil under the instruction of Sqn. Ldr. E. J. Furlong, D.F.C. Few gliding schools are fortunate enough to possess two-seaters, and usually all training is carried out in the single-seat Kirby Cadet.

Women's Auxiliary Air Force

WOUNDED OR INJURED ON ACTIVE SERVICE.—Cpl. J. E. D. Thompson.

DIED ON ACTIVE SERVICE.—A/CW.1 H A. Bacchus; S/O. B. H. S. Cochran.

Royal Australian Air Force

MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—P/O. A. C. F. Klingner.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—F/O. L. V. Barnett; Act. F/O. R. W. Brown, D.F.C.; W/O. J. N. Casey; Flt. Sgt. F. J. Cook; Flt. Sgt. W. A. Gillard; Act. Flt. Lt. R. G. Godfrey; F/O. C. D. Hamilton; F/O. F. S. Hawkes; Flt. Sgt. N. R. Keys; Act. F/O. T. N. McCurdy; Flt. Sgt. S. McLean; F/O. C. W. P. Mortel; Flt. Sgt. D. J. Oliver; W/O. F. J. L. Paton; F/O. G. J. Pursey; P/O. E. Ray; Flt Sgt. H. J. Smith.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—P/O. P. Myerson.

Royal Canadian Air Force

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—F/O. W. H. Morrison; Flt. Sgt. W. A. Wright.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—P/O. R. Allan; F/O. W. F. Anderson; F/O. K. H. Barker; F/O. T. F. Barker; F/O. A. Barr; F/O. W. H. L. Bellingham; Flt. Sgt. R. A. Best; F/O. J. Bilbe; F/O. K. B. Brooks; Flt. Lt. W. W. L. Brown; P/O. H. A. Burt; Flt. Sgt. R. W. Carroll; F/O. A. D. Chapman; Flt. Lt. R. L. Clearwater; F/O. E. T. Coles; Flt. Sgt. M. A. Cook; Flt. Lt. P. E. Cronyn, D.F.C.; F/O. T. G. Curphey; P/O. G. F. Dawson; Flt. Sgt. R. A. Dowling; Sgt. G. A. Dunkelman; P/O. J. P. Durkin; P/O. J. W. Erickson; F/O. K. D. Farrow; P/O. W. J. Fingland; P/O. A. L. Flatt; F/O. J. Futoranski; F/O. R. C. Gibbs; P/O. W. I. Girvin; F/O. C. Gray; Flt. Sgt. W. Greene; P/O. J. D. Griffin; P/O. L. G. H. Griffiths; Flt. Sgt. G. T. Hallam; P/O. I. McC. Hamilton; P/O. T. A. Harrington; F/O. P. F. C. Haydock; F/O. J. B. Hill; F/O. F. A. Horning; F/O. R. O. Hunter; P/O. L. J. Innes; F/O. H. A. Jeffreys; Flt. Sgt. N. F. Jozell; F/O. A. N. Johnston; P/O. T. R. Kelly; Flt. Lt. W. W. Kennedy; Flt. Lt. A. L. Kirsch; F/O. H. Knobovitch; F/O. A. Kozlof; F/O. J. A. R. L. La Palme; F/O. P. Leeds; W/O. R. G. Leonard; F/O. W. J. Long; P/O. L. W. Love; Flt Lt. L. R. B. Loving, D.F.C.; P/O. T. H. Lunnin; F/O. N. E. H. McConnell; P/O. W. A. MacWilliam; P/O. N. Marshall; P/O. P. J. F. Mitchell; Flt. Sgt. L. J. Moore; Sgt. M. R. Morton; F/O. N. C. Muir; P/O. A. J. Murphy; Flt. Lt. J. R. Murray; P/O. J. E. O'Brien; F/O. A. B. Orchard; F/O. J. M. Parkinson; F/O. L. P. E. Piche; F/O. D. M. Price; F/O. C. G. Redden; F/O. R. J. Reilly; F/O. R. E. Rennie; Flt Sgt. W. W. Rennie; Flt. Sgt. C. C. Robertson; Flt. Sgt. A. E. Robson; P/O. G. A. Running; P/O. R. C. Schlievert; P/O. C. Service; Flt. Sgt. J. R. Seymour; P/O. G. A. Slater; W/O. J. Spiegel; W/O. J. L. Springsteele; Flt. Sgt. J. A. W. Sutherland; F/O.G. T. Terris; P/O. V. L. Valde; F/O. R. W. Vokey; Sgt. W R. White; P/O. J. S. Williamson; Flt. Sgt. T. Yates; Flt. Lt. J. C. Younge.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Flt. Lt. M. Ewaschuk.

MISSING, BELIEVED KILLED IN ACTION.—F/O. W. S. Bradley; F/O. M. A. Russell.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—F/O. T. R. Bailey, D.F.C.; Sgt. A. E. Cooper; W/O. J. F. Emery; Sgt. R. S. Gray; F/O. E. A. Hine; P/O. E. J. Kennedy; F/O. J. E. Osborn; L.A/C. N. F. Ready.

DIED ON ACTIVE SERVICE.—L.A/C. R. S. Ball.

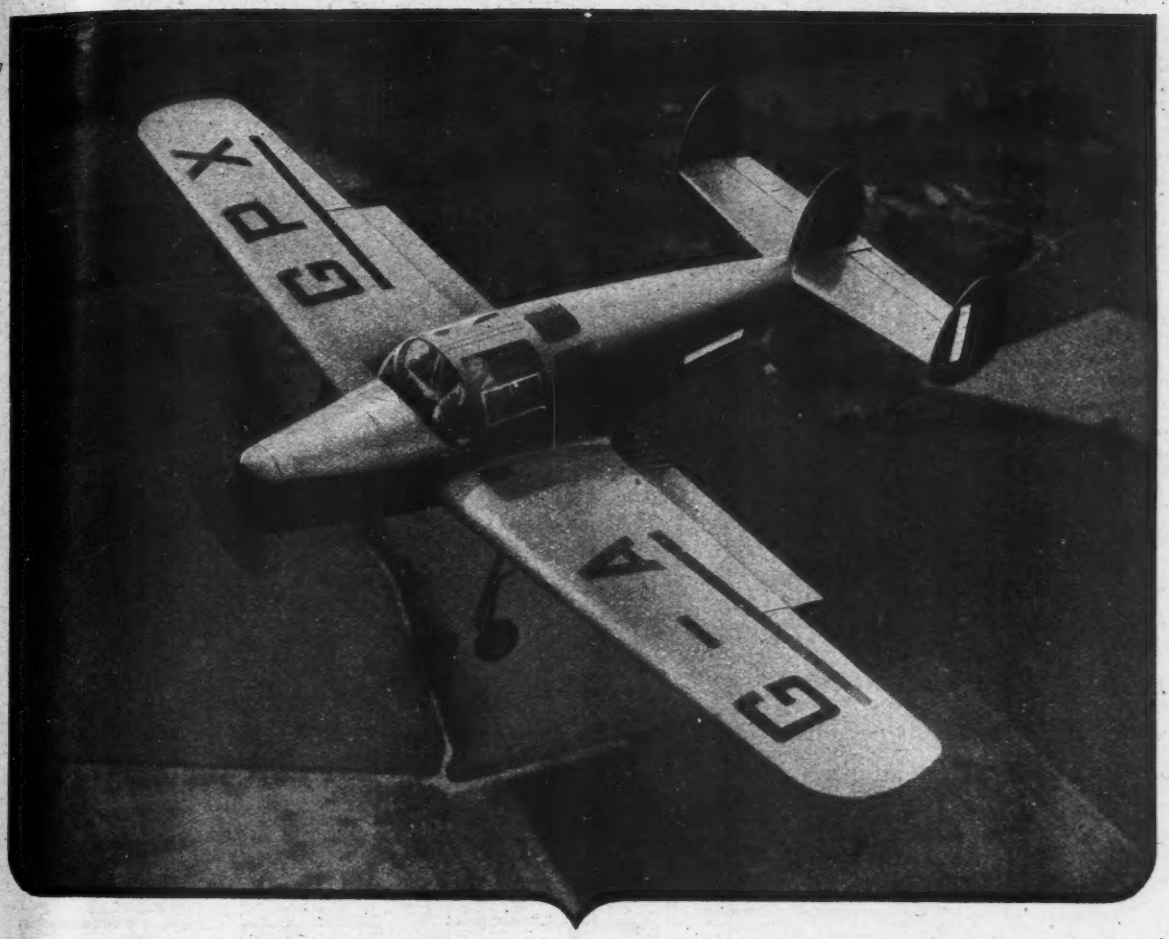
Royal New Zealand Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. W. E. Brunton; F/O. L. F. Croft; P/O. F. W. R. Cumpsty; Flt. Sgt. T. S. Edwards.

KILLED ON ACTIVE SERVICE.—W/O. D. C. Burman.

South African Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Lt. A. E. Collett; Lt. E. W. Hall; Lt. D. M. A. Hunter, D.F.C.; Lt. G. B. Marquard; Capt. R. H. Povey.



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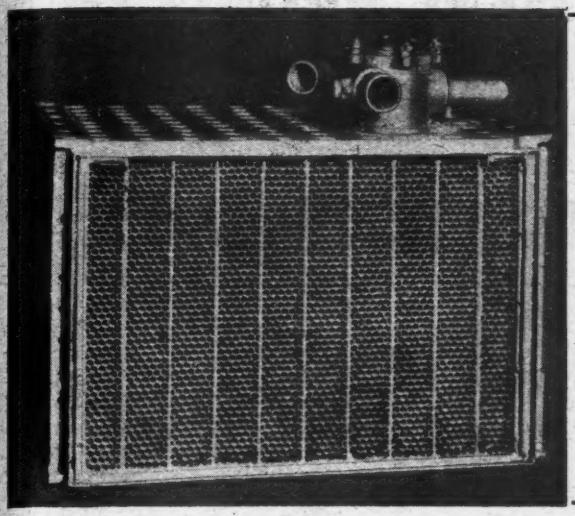

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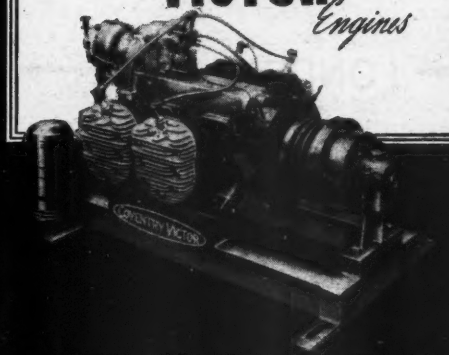

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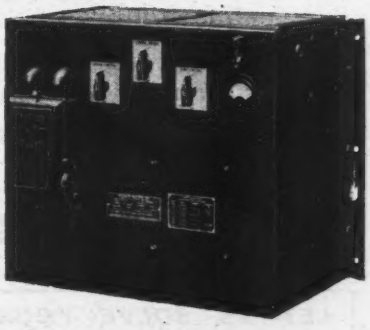

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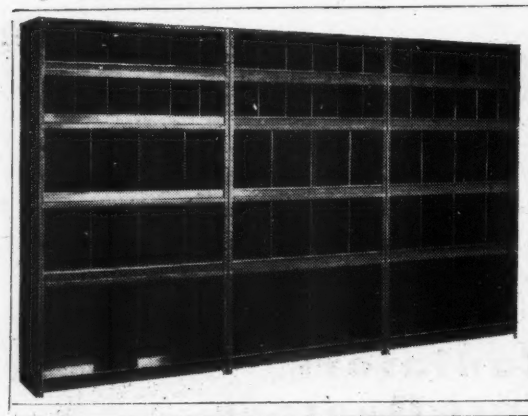

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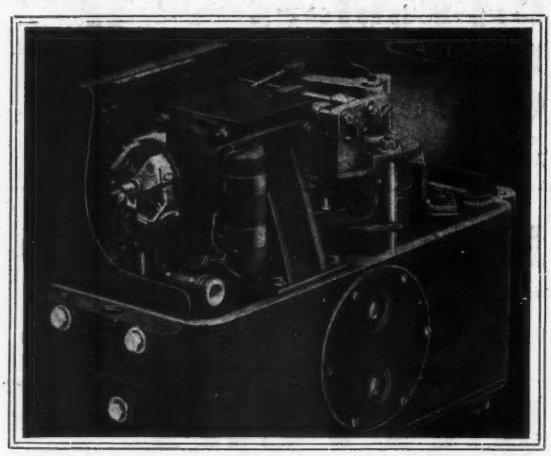

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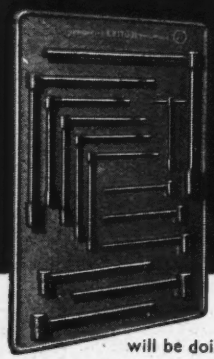

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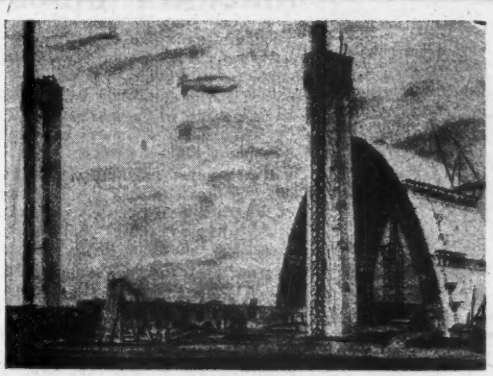

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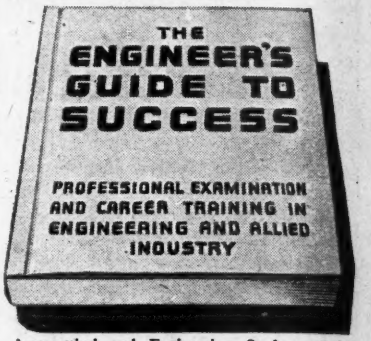

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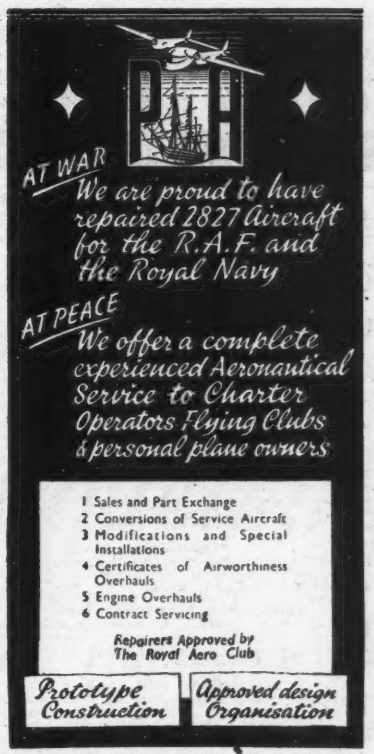
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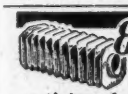

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"Flight" can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: Imperial News Co., Gordon & Gotch, Ltd.
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